Public-Safety Radio Integrated Systems Management

PUBLIC•SAFETY RADIO INTEGRATED SYSTEMS MANAGEMENT

PRISM PROGRAM

California presentation to colleagues at the

Public Safety Wireless Network Las Vegas Symposium

October 24th, 2001

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AGENDA

1. A Prelude to Action
2. A Compelling Case for Change
3. Project Background
4. A Vision for Public Safety Radio
5. Alternatives Analysis
6. Proposed Systems Solution
7. Characteristics
8. Implementation
9. Risk Areas/Critical Success Factors
10. Concept Demonstration (Pilot)

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ALLIED AGENCY PARTICIPANTS

CHP

DOT

CDF

DFG

CDC

DPR

"Public Safety, Public Service" ©

DOJ

EMSA

OES

CYA

DWR

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STATE PUBLIC SAFETY AGENCY BASIC MISSION

- "…to provide effective [*e.g., coordinated, etc.*] and reliable law enforcement, fire protection, emergency response, transportation management, flood control, detention, rehabilitation, and other public safety services to over 34 million California residents and 44 million California visitors each year."

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A COMPELLING CASE FOR CHANGE...

- Current California Radio Communications System Status
  - "...lack of effective and reliable radio communications is impeding California's state public safety agencies' ability to perform their most elemental mission: the protection of life and property…."

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A COMPELLING CASE FOR CHANGE...

- Existing California State Radio Systems
  - Lack of Interoperability
    - Separate and incompatible radio systems
  - Channel congestion
  - Antiquated systems and aging equipment
  - Some systems no longer supported

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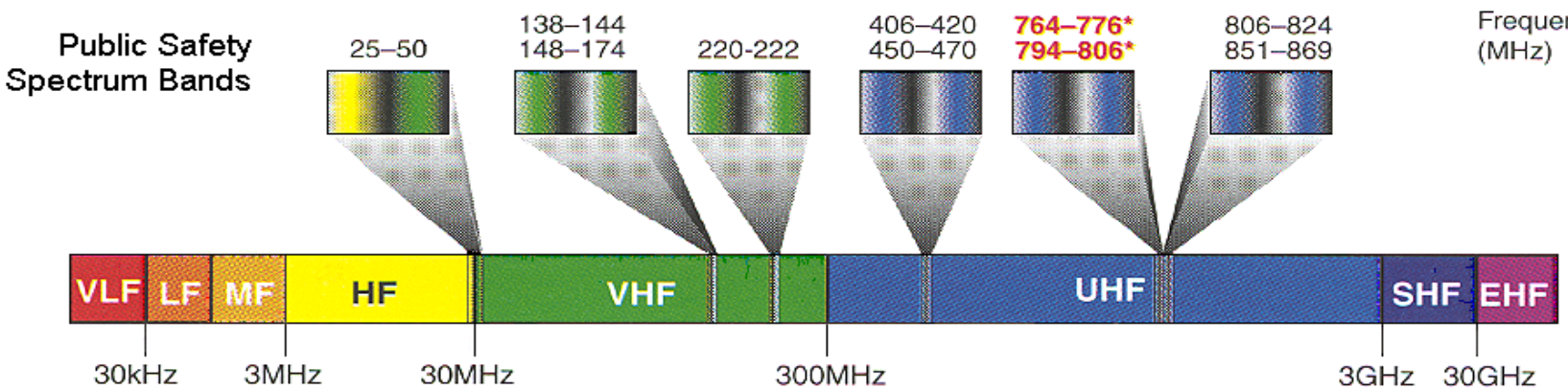
A COMPELLING CASE FOR CHANGE...

What are the public safety bands from which we can attempt to obtain frequencies?



* Additional spectrum bands (764 to 776 MHz and 794 to 806 MHz) allocated for public safety use as part of the Balanced Budget Act of 1997.

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A COMPELLING CASE FOR CHANGE...

- Associated Risks of Deteriorating Radio Systems
  - Endangerment of field personnel
  - Lower levels of service
  - Obsolescence
  - Inability to support future growth

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A COMPELLING CASE FOR CHANGE...

- Narrowing Window of Opportunity
  - Competition for Spectrum Resources
    - demand is exceeding availability
  - Changing Regulations
    - narrow-banding, et cetera
  - New Technologies
    - increased functionality allows greater flexibility
  - Rising Costs
    - to maintain old systems

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CALIFORNIA'S RESPONSE

- The State's ten largest public safety agencies and DGS initiated a collaborative effort to develop a statewide strategy for public safety radio communications. Recognizing the potential benefits of partnering, the Public Safety Radio Strategic Planning Committee was established in 12/94

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PROJECT BACKGROUND

12/94	***Strategic Planning Committee established***
8/95	Internal assessments completed
12/95	Current systems surveyed
3/96	Operational needs and requirements defined;
	Over 200 agency employees provided input
7/96	Strategic vision defined;
	Recommendations developed
1/97	***Strategic Plan adopted by Committee***
5/97	Initial sub-committees formed

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PROJECT BACKGROUND

6/97	Cost-benefit alternatives analysis begun
8/97	State radio coverage modeling begun;
	State radio traffic load analyses begun
12/98	First pilot project areas selected for evaluation
4/99	***Cost-benefit analysis finalized***
5/99	Pilot project scope finalized
9/99	Budget Change Proposal submitted for the pilot project
1/00	***Governor's Budget includes pilot initial planning and design funding ($3.4 million)***

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A VISION FOR PUBLIC SAFETY RADIO

The California Public Safety Radio Strategic Planning Committee Vision:

…to leverage existing investments in infrastructure while moving rapidly and decisively to meet targeted goals for universal statewide access, improved interoperability, enhanced functionality, and adequate channel availability.

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STRATEGIC ALTERNATIVES CONSIDERED

- Each Agency Meets Its Own Requirements By Building Systems Independently

- Agencies Meet Requirements By Building A Common (Shared) Network

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STRATEGIC ALTERNATIVES CONSIDERED

- $4.3 Billion* Each Agency Meets Its Own Requirements By Building Systems Independently

- $3.5 Billion* Agencies Meet Requirements By Building A Common (Shared) Network

*15 Year Life Cycle Cost (comprises all site development and leasing costs, system[s] maintenance, replacement equipment, circuit fees, et cetera)

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ALTERNATIVES ANALYSIS

- Functional Criteria
  - Does element meet individual and collective needs?
  - Does element enhance mission readiness/ capabilities?
- Fiscal Criteria
  - Is it cost effective?
  - Do benefits outweigh costs?
  - Is additional funding required?

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ALTERNATIVES ANALYSIS Continued

- Availability Criteria
  - Technology/spectrum available?
  - What is life expectancy?
  - Will vendors support element long-term?
  - Is element backward compatible/forward migratable?
  - Open architecture?
- Et Cetera

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TECHNOLOGICAL ALTERNATIVES CONSIDERED

- Implement a Satellite-Based Communications System(s)
- Build a UHF-Only (406-869 MHz) Voice/Data Network of Systems
- Build a Hybrid (VHF HB/UHF) Voice/Data Network of Systems

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PROPOSED SYSTEMS SOLUTION

Conclusion:

- Shared, statewide, public safety radio communications network comprised of:
  - Hybrid voice and data networks
    - Use of multiple technologies and frequency bands
  - System optimization necessary to meet agency-unique requirements
  - Leveraging existing facility and equipment investments

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PROPOSED SYSTEMS SOLUTION

Why Do It This Way?

- Compelling reasons for shared interagency network approach
  - technology changes compel movement
  - federal mandates and initiatives
  - state cannot afford independent systems
  - facilitates interagency interoperability
  - faster, more accurate access to information

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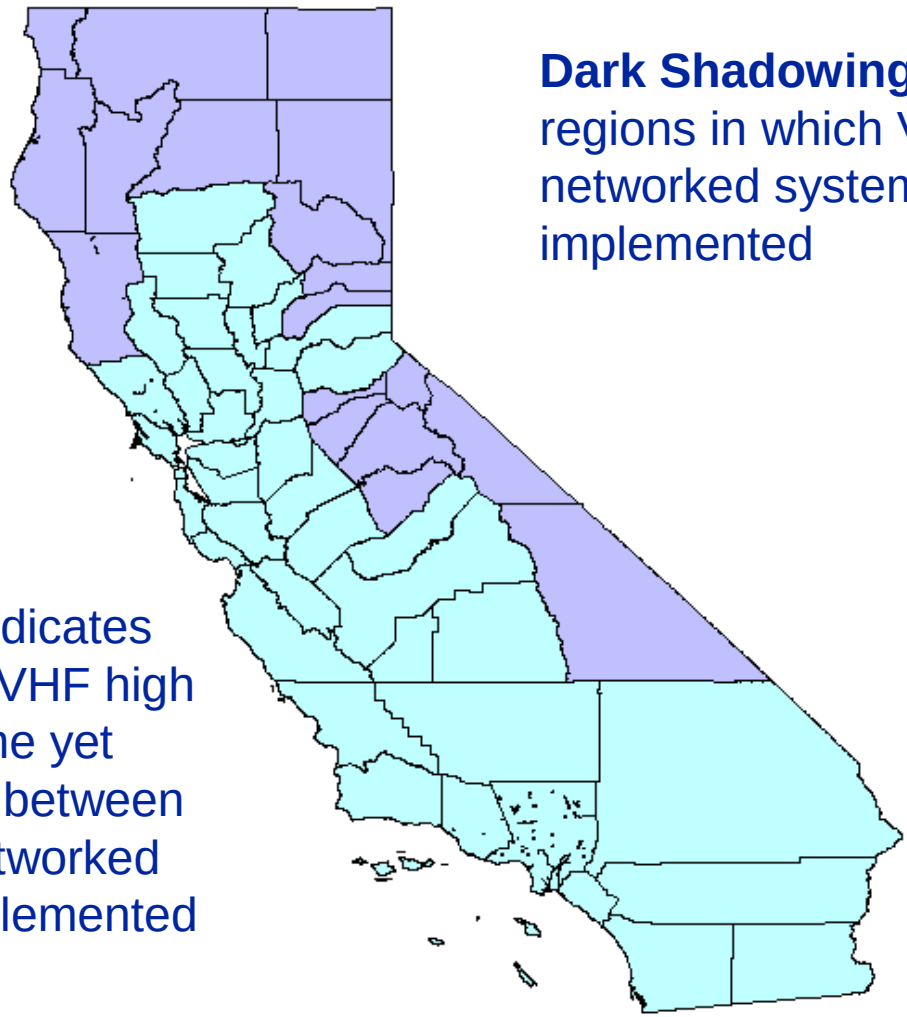
HYBRID (VHF HB/UHF) VOICE/DATA NETWORK



Dark Shadowing: Indicates regions in which VHF high band networked systems are to be implemented

Light Shadowing: Indicates regions in which both VHF high band and UHF (in some yet unknown allocation[s] between 406 and 869 MHz) networked systems are to be implemented

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PROPOSED SYSTEMS SOLUTION

- Compelling reasons for a trunked voice radio network approach
  - full-featured radio communications
  - channel congestion relief (with same number of channels)
  - agency autonomy is retained
  - permits prioritization of users and messages

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PROPOSED SYSTEMS SOLUTION

- Compelling reasons for a mobile data network approach
  - rapid transmission of information
  - reduced requirement for human intervention
  - reduced voice channel congestion
  - increased operational efficiency
  - improved personnel safety when emergency access to voice channels is necessary

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IMPLEMENTATION

- Concepts Tested With Initial Deployment Project (2002 through 2004)
- Phased Build-Out Over Fifteen Years (2002 through 2017)
  - Subsequent area sequences based on selection criteria
    - greatest operational need
    - availability of spectrum within candidate area
    - best opportunity

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IMPLEMENTATION

- Graceful Transition From Old To New Radio System
  - Ability to revert to existing radio system for predetermined period
    - vehicle fleet and sites equipped with old and new for a time
    - communications centers able to transmit on old and/or new radio systems

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IMPLEMENTATION

- Phased Build-Out Over Fifteen Years

	Years
Initial Deployment	1 - 4
Majority of Infrastructure Build Out	4 - 12
Department Transitions	3 - 15

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RISK AREAS

- Spectrum
  - Availability
    - When and where needed
      - competition
        - commercial
        - public safety
  - Adequacy
    - Sufficient to meet current & future traffic load needs of proposed and future participants

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RISK AREAS

- Facilities
  - New or existing site acquisition/development
    - Availability in the time frames needed
      - critical to meeting cost and schedule targets
    - Adequate
      - space and services
        - tower, vault, HVAC, power, et cetera
    - Unforeseens
      - Environmental, city council, bureaucratic, et cetera opposition to any new/further site development

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RISK AREAS

- Funding
  - Sequenced development dependent on timely availability of $$$'s
    - Delays in funding will result in escalating costs
  - Program spans multiple administrations
    - Could lose funding
    - Could lose political support

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RISK AREAS

- Vendors
  - Ability to meet scope, schedule, and cost objectives
  - Proprietary architectures
    - Incompatibility with other vendor protocols
    - Sole-source solution
  - Solution(s)
    - Viability, reliability, and maintainability over 15 years

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RISK AREAS

- State Services
  - Interagency cooperation
  - Ability to meet scope, schedule, and cost objectives
    - Critical to program success
    - Failure to do so will result in escalating costs and compounded schedule delays

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CALIFORNIA IN PERSPECTIVE

- **Comprises 158,869 mi², an area comparable to the the combined areas of the following adjacent states:**
  - Pennsylvania (46,058 miles²),
  - New York (53,989 miles²),
  - Vermont (9,615 miles²),
  - New Hampshire (9,283 miles²),
  - Massachusetts (9,241 miles²),
  - Connecticut (5,544 miles²),
  - Rhode Island (1,231 miles²),
  - New Jersey (8,215 miles²),
  - Delaware (2,396 miles²),
  - Maryland (12,297 miles²), and
  - Washington, D.C. (68 miles²)

or, 157,937 miles².

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CALIFORNIA IN PERSPECTIVE

- 770 miles in length
  - Comparable distances:
    - Philadelphia, Pennsylvania to Jacksonville, Florida (761 miles)
    - Chicago, Illinois to Mobile, Alabama (770 miles)
    - Fort Worth, Texas to Atlanta, Georgia (750 miles)
    - Las Vegas, Nevada to Amarillo, Texas (753 miles)
    - Butte, Montana to Flagstaff, Arizona (745 miles)
- 250 miles wide

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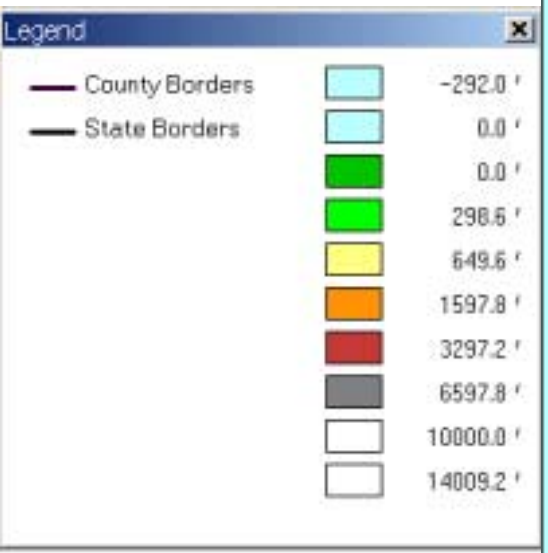

Lowest point: Death Valley (-282 ft.)

Highest point: Mount Whitney (14,494 ft.)

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Radio Propagation Model

- National Bureau of Standards NBS-101 (Improved Longley-Rice Model)
- Universal Model - for varying terrain types
- USGS 3 arc second terrain elevation data
- Newly available Land Use, Land Cover (LULC) data*

*Additional signal loss to mobile unit due to its surrounding environment

Partial Legend of Symbols

- TD Maintained Sites (Appearance 1: Selected)
- TD Maintained Sites (Appearance 2: Var Colors UNSelected)
- San Diego Co Regional Communications System Sites
- CHP Remote Base Stations (Appearance 1)
- CHP Remote Base Stations (Appearance 2)

County Population in Thousands

- 1.2K to 250K
- 250K to 1,000K
- 1,000K to 2,500K
- 2,500K to 5,000K
- 5,000K and Up

Radio Coverage Colors Breakdown

- NO Coverage
- Not Adequate
- Adequate
- GOOD Coverage
- Site Vicinity

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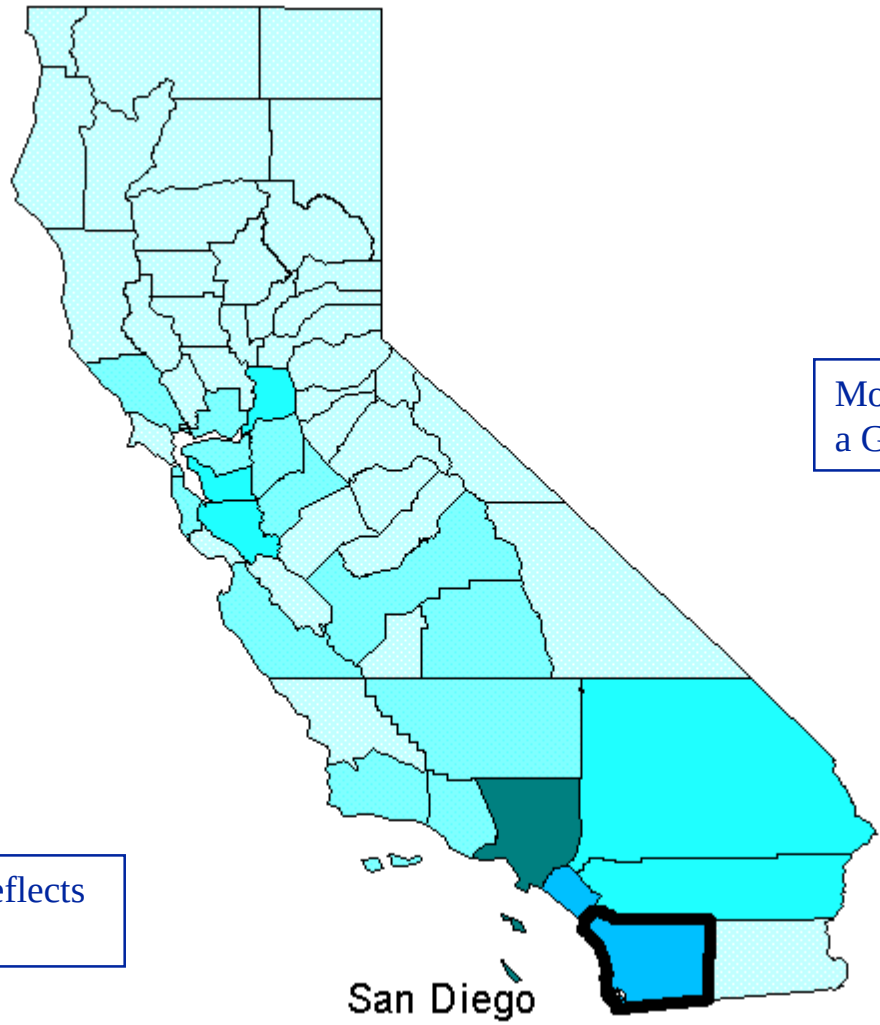

Most views output from a GIS data system

Background colors reflects population levels.

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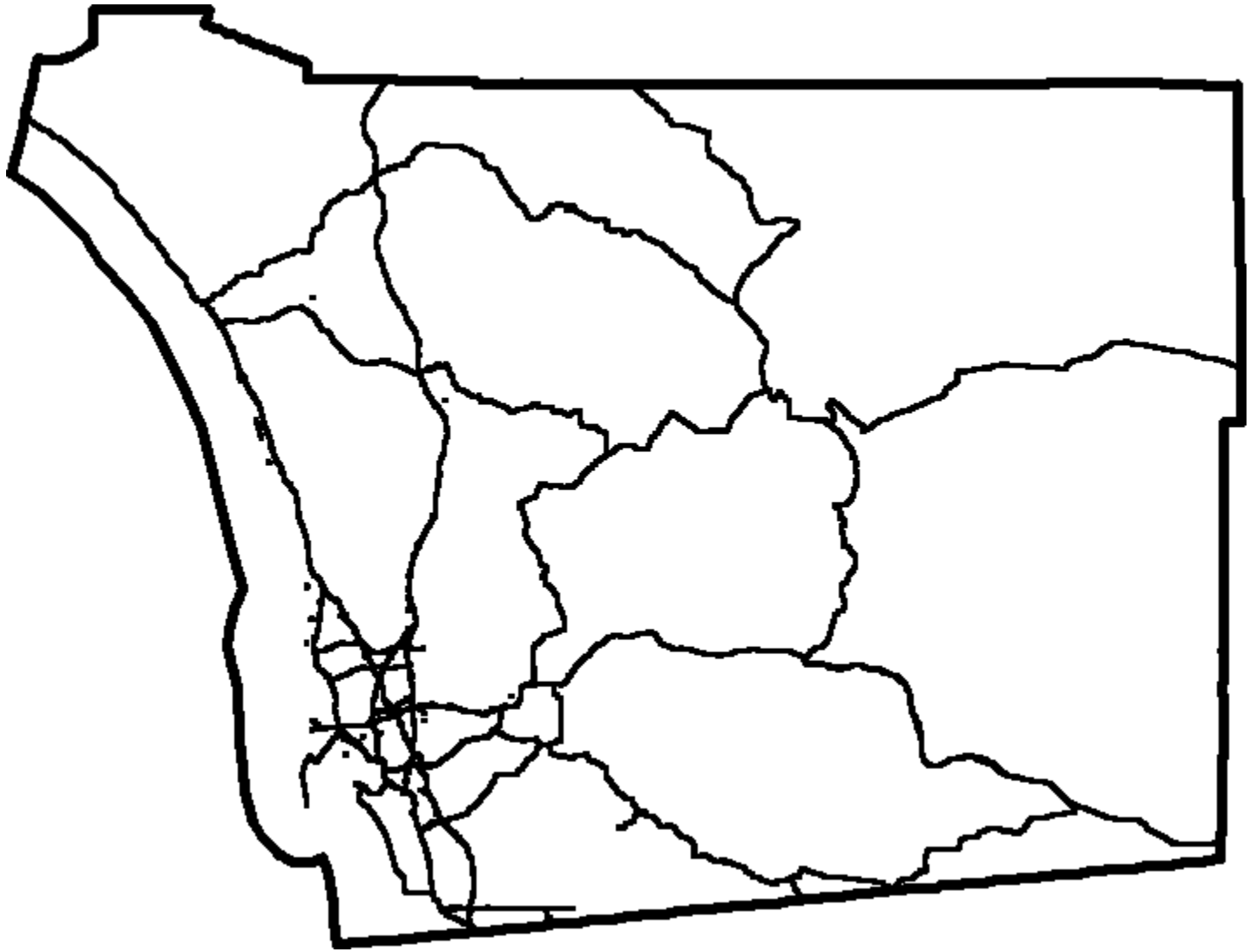

San Diego County - Primary Roads

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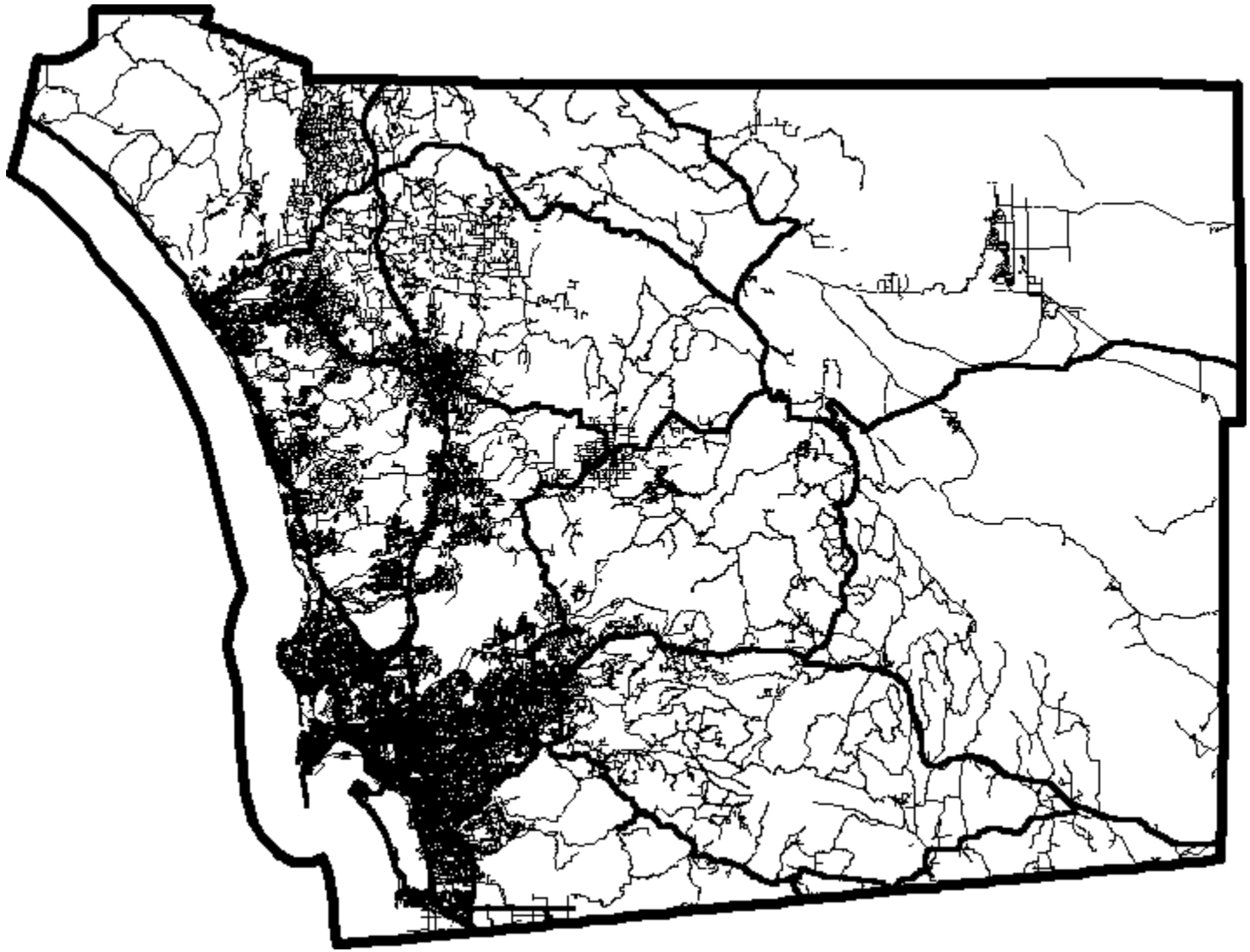

San Diego County - Primary & Secondary Roads

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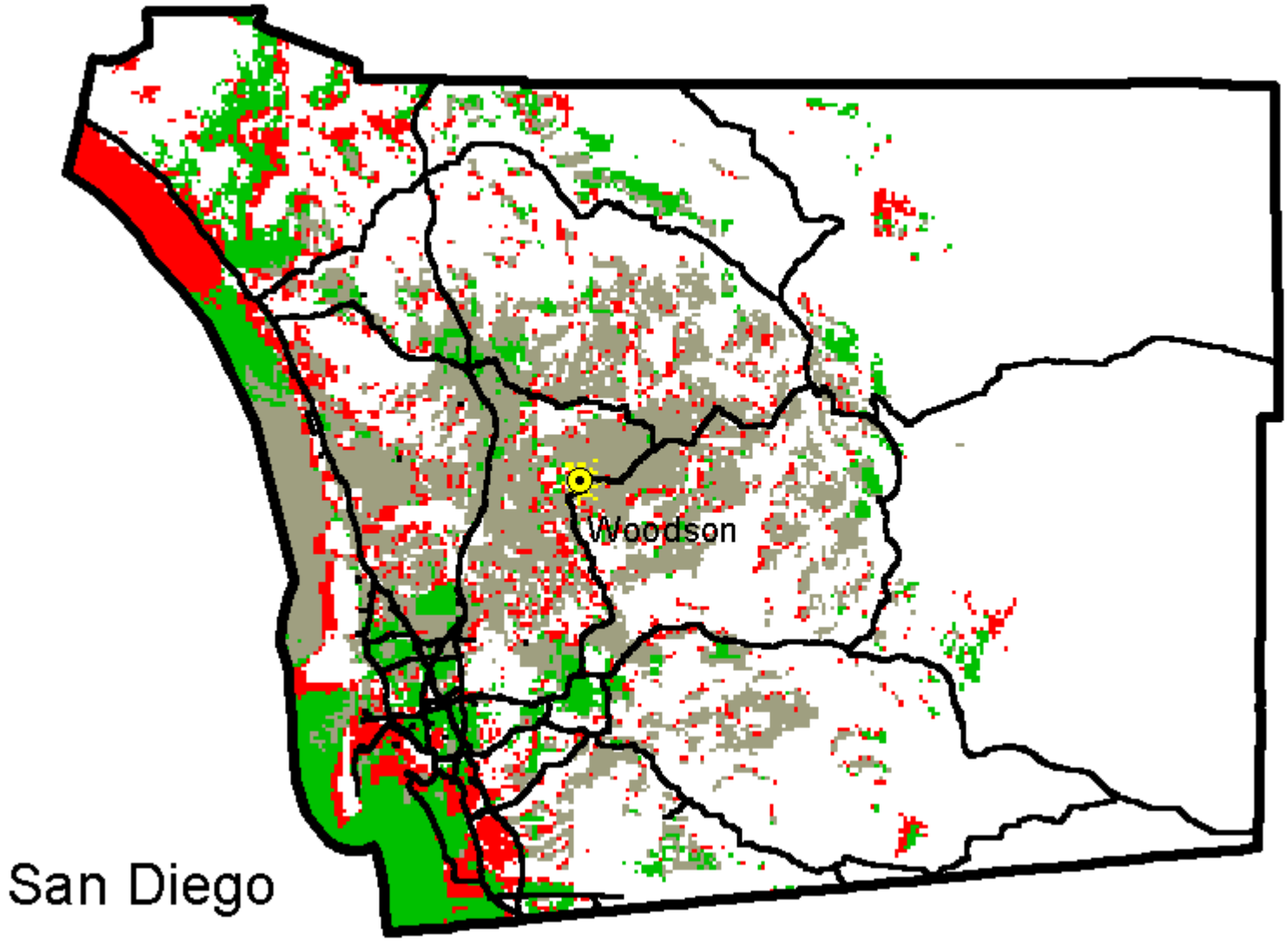

San Diego County Coverage - 1 Site Example

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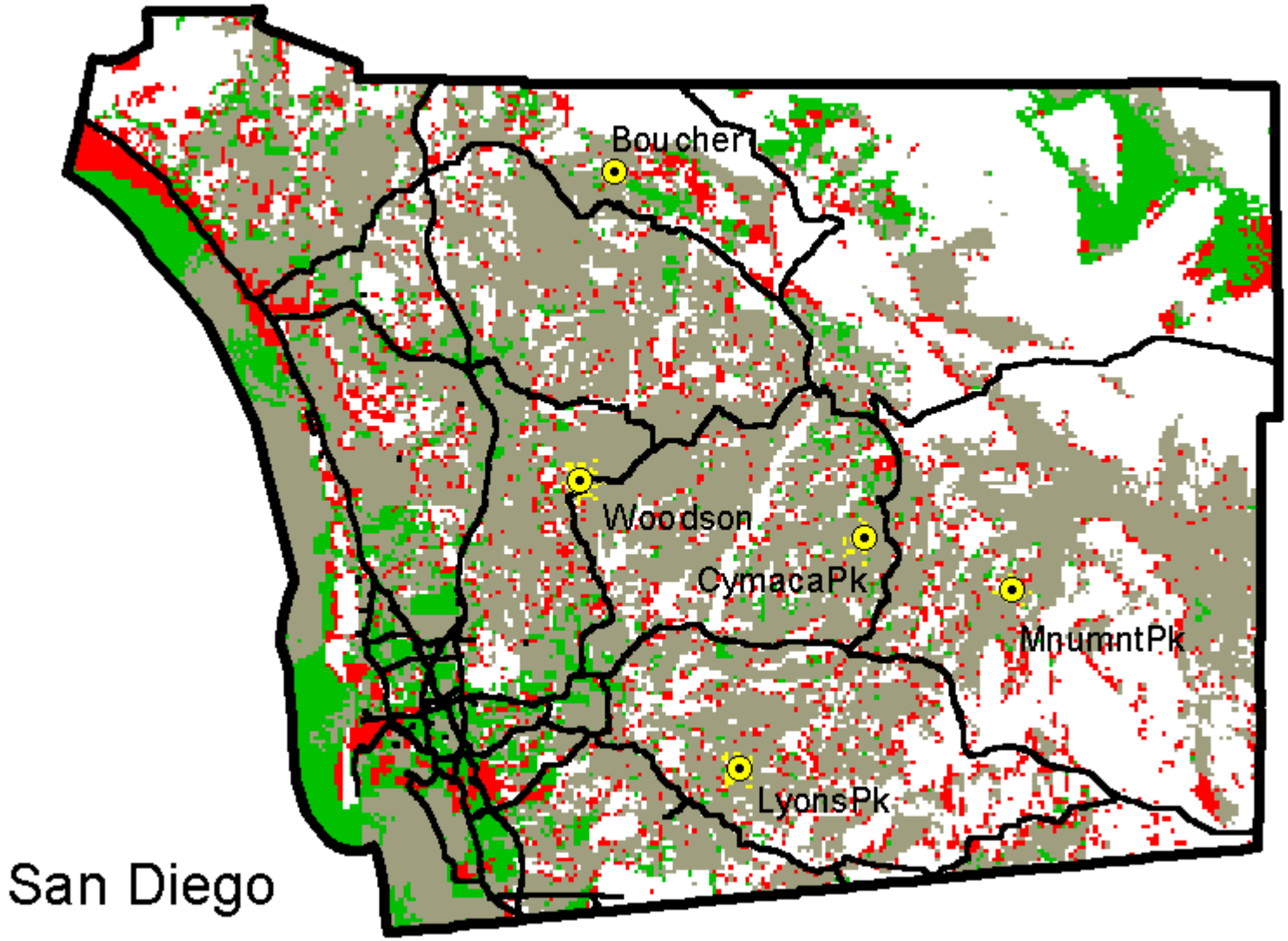

San Diego County Coverage - 5 Site Example

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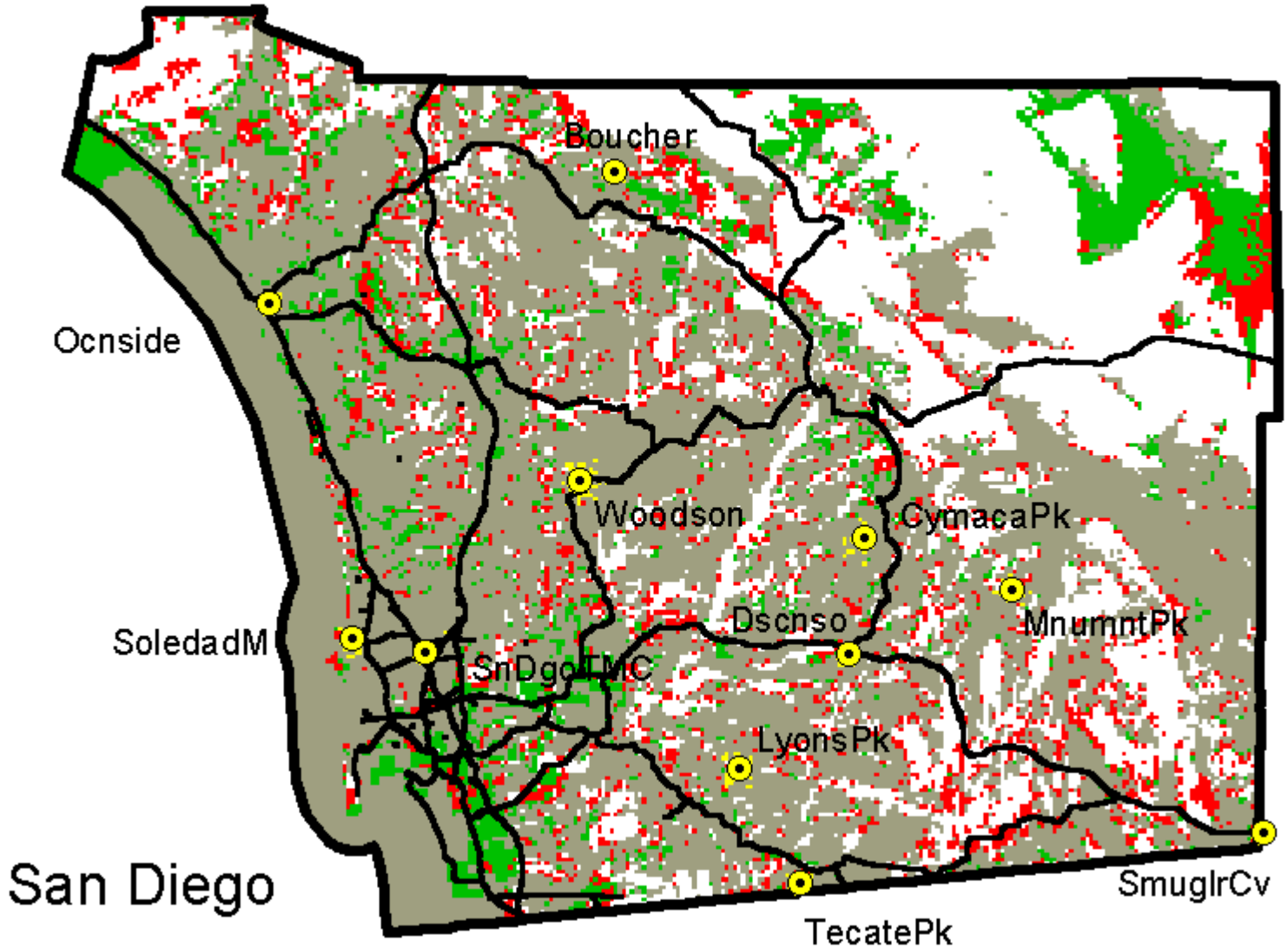

San Diego County Coverage - 11 Site Example

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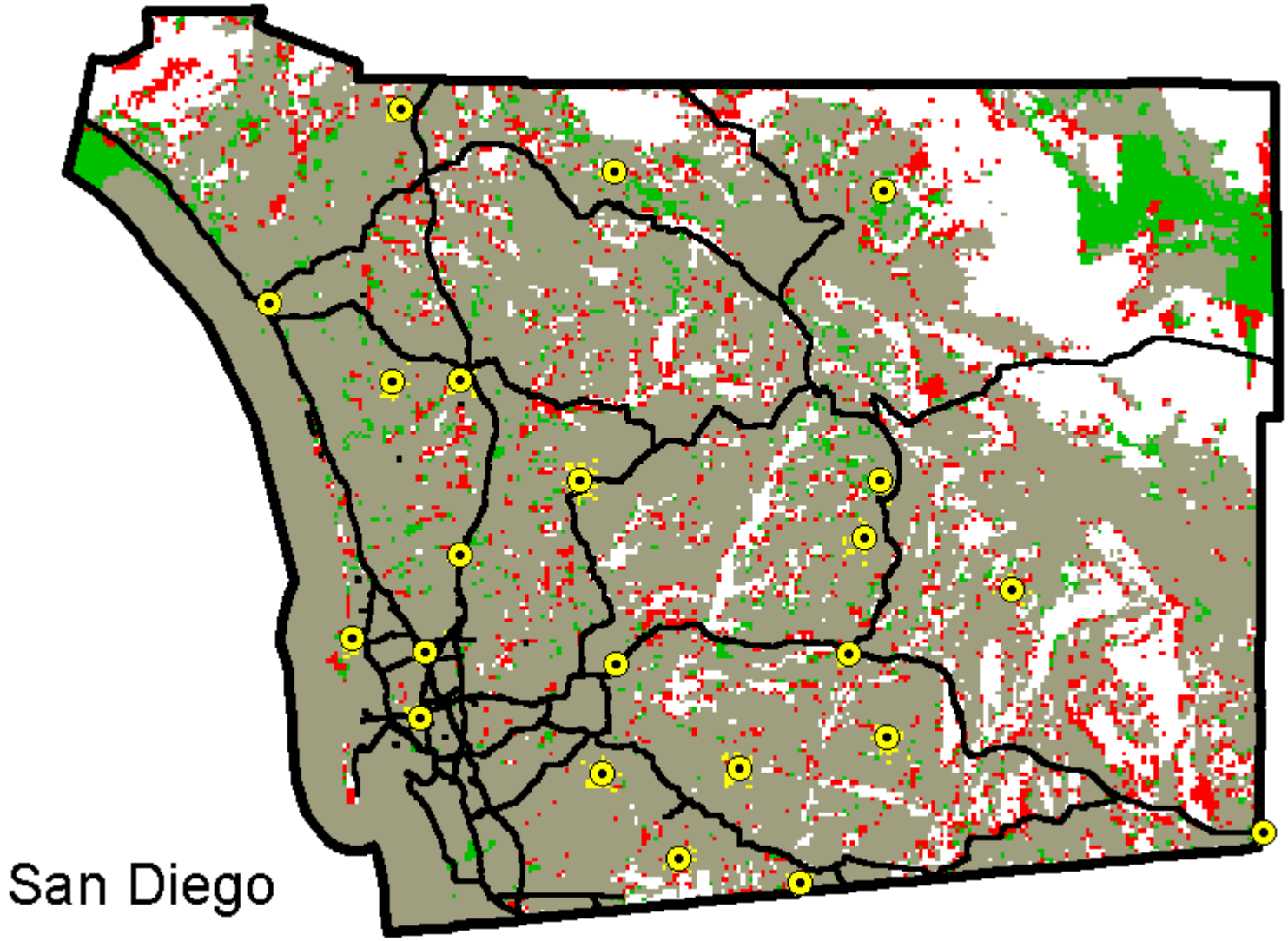

San Diego County Coverage - 22 Site Example

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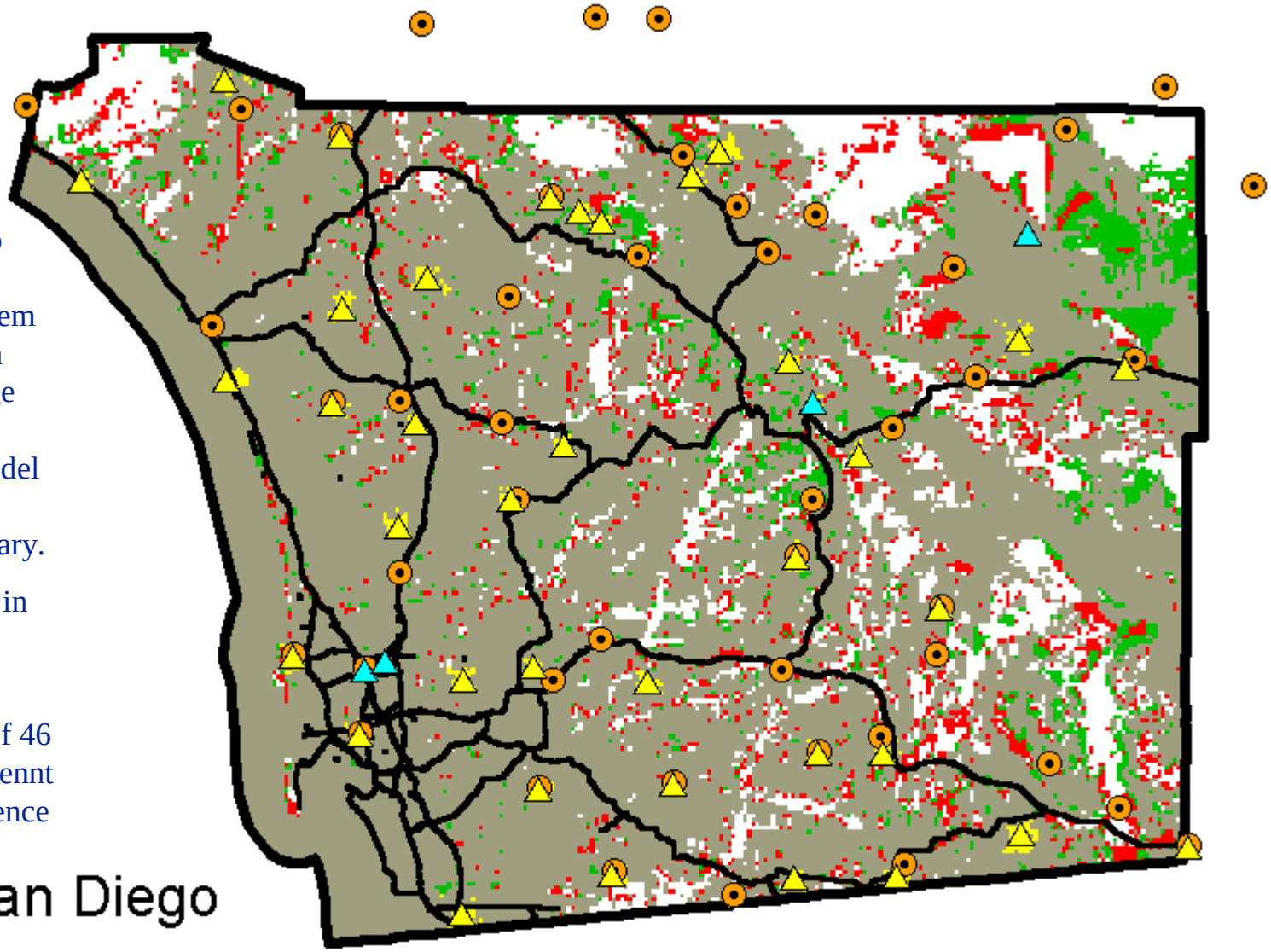
- Triangle = San Diego County Regional Communications System Calculated Sites (circa 1998). Note: Coverage represents *predicted* coverage based on model used by CA DGS TD; actual coverage will vary.
- Superstition Mtn site in Imperial County not shown
- Circles = Locations of 46 State sites (in subsequennt slide) shown for reference



San Diego County Coverage - 39 County RCS Sites

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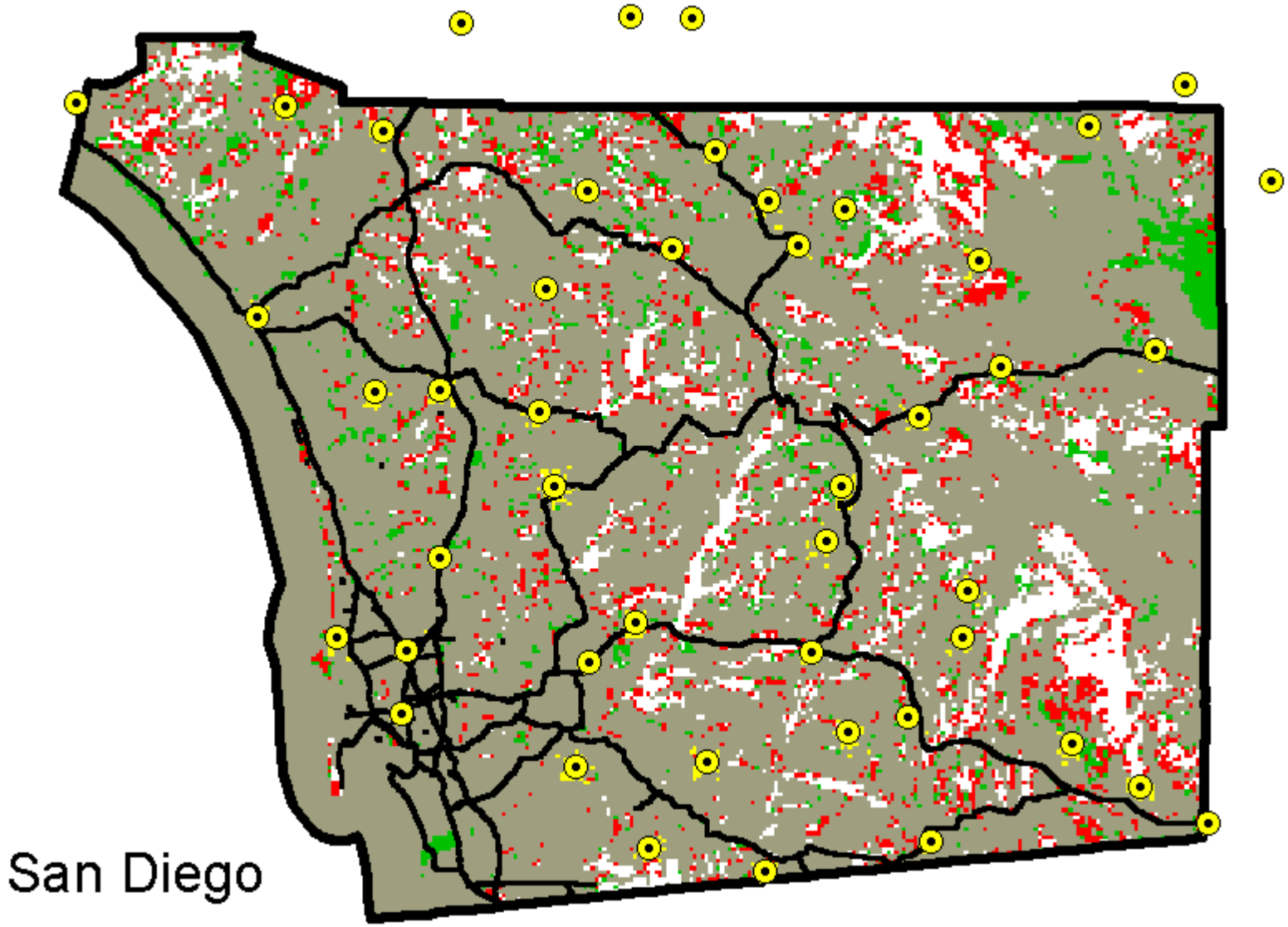

San Diego County Coverage - 46 Site Example

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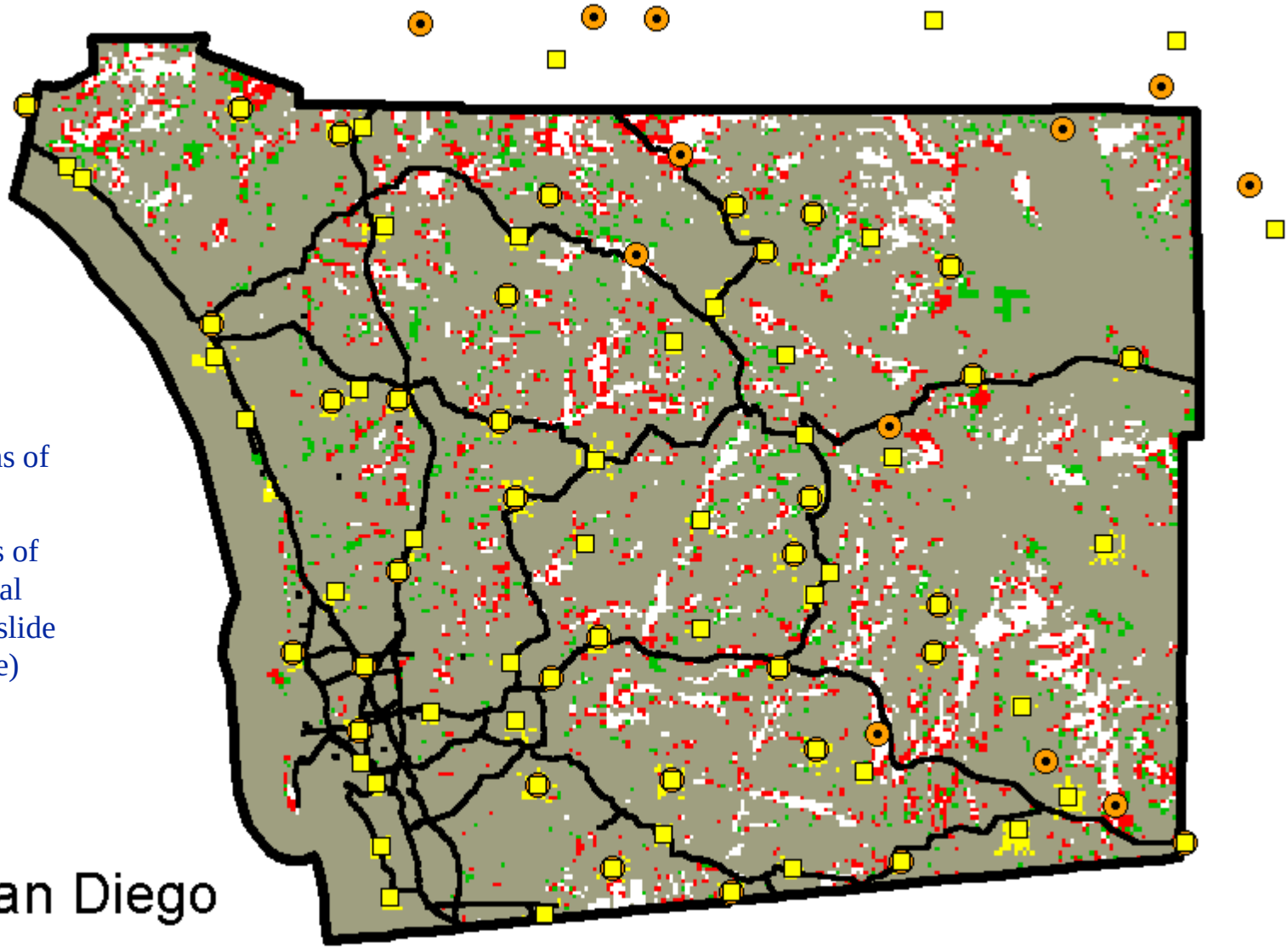
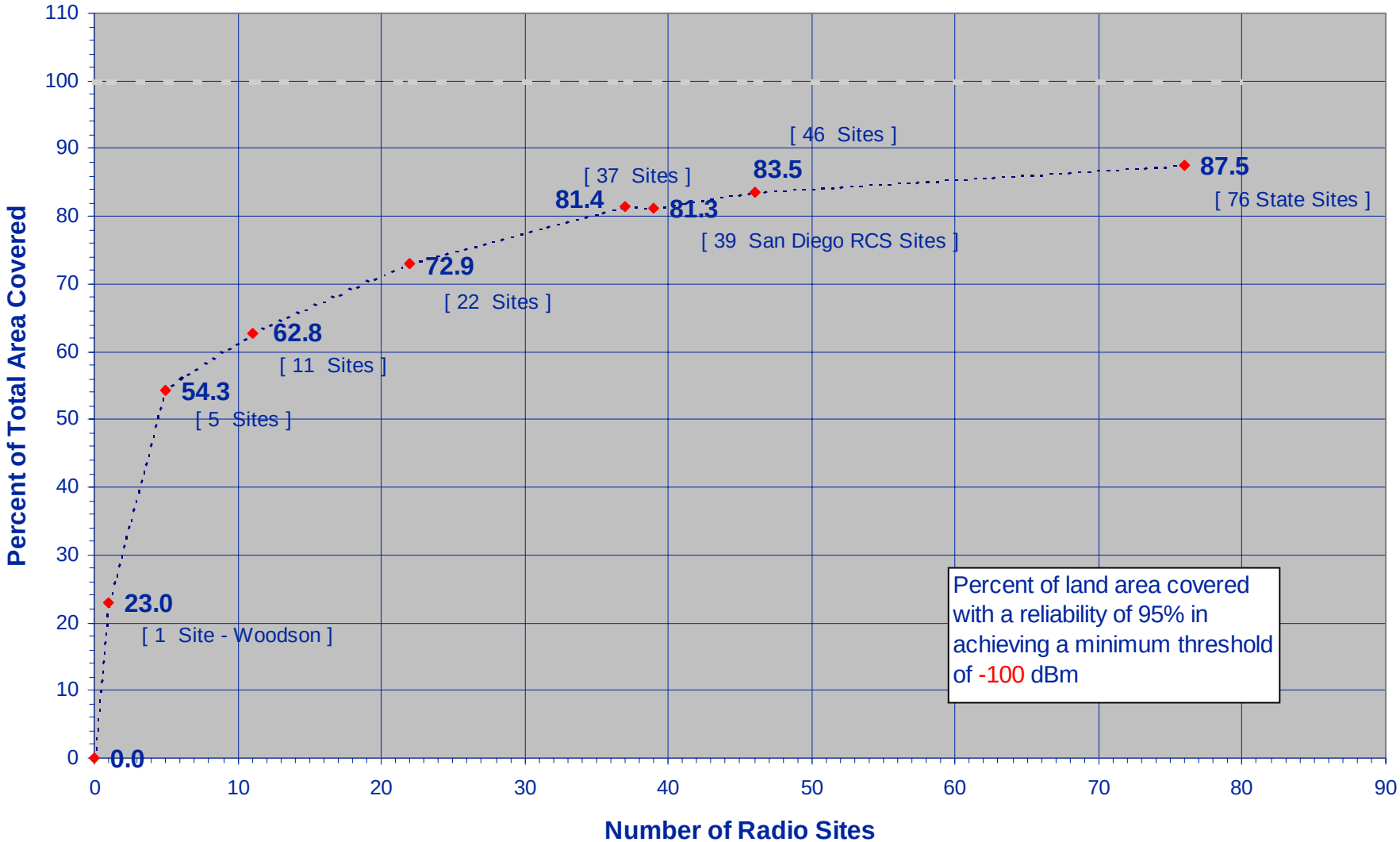


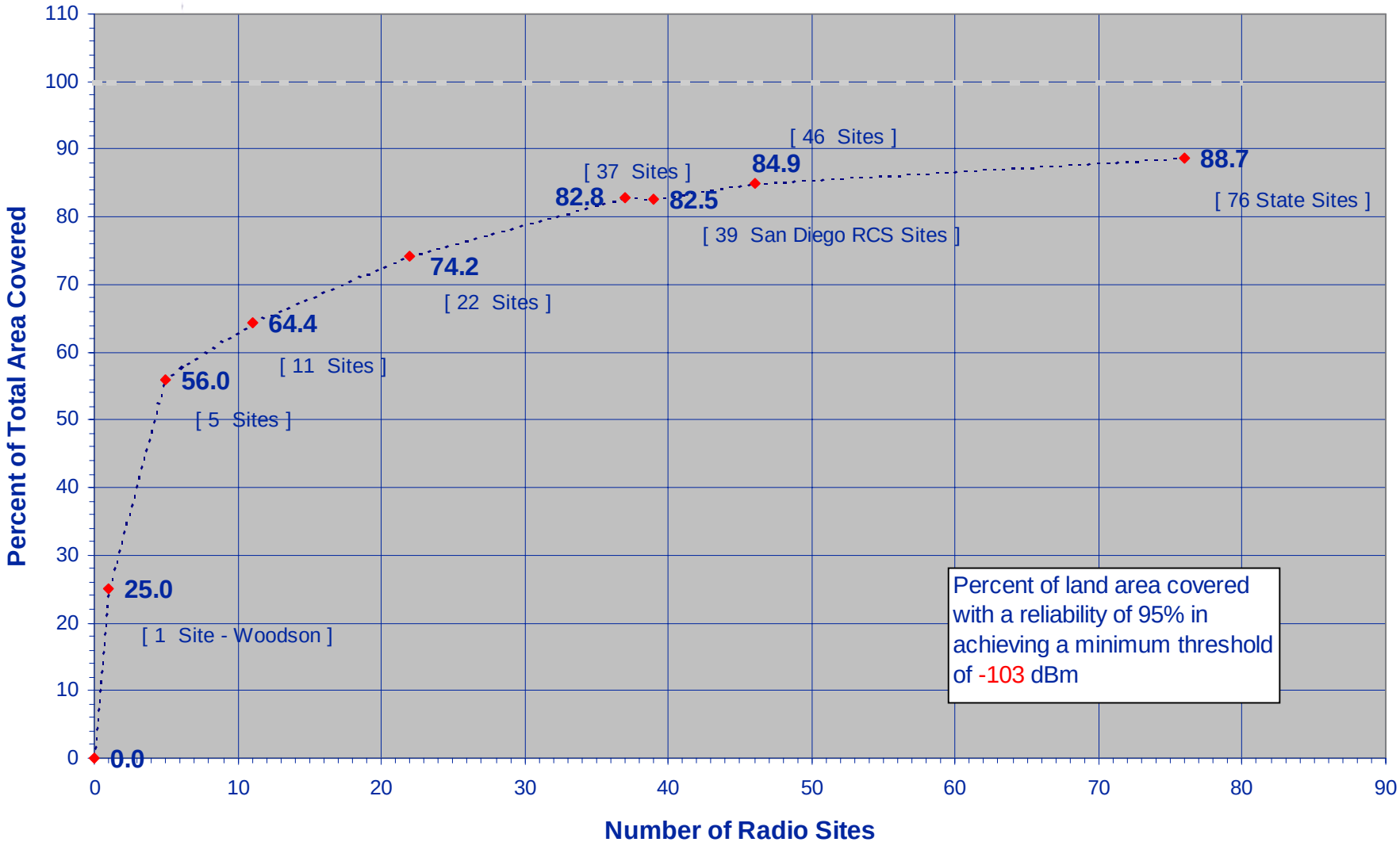
- Squares = Locations of 76 calculated sites
- Circles = Locations of 46 State and Potential sites from previous slide (shown for reference)

San Diego County Coverage - 76 Site Example

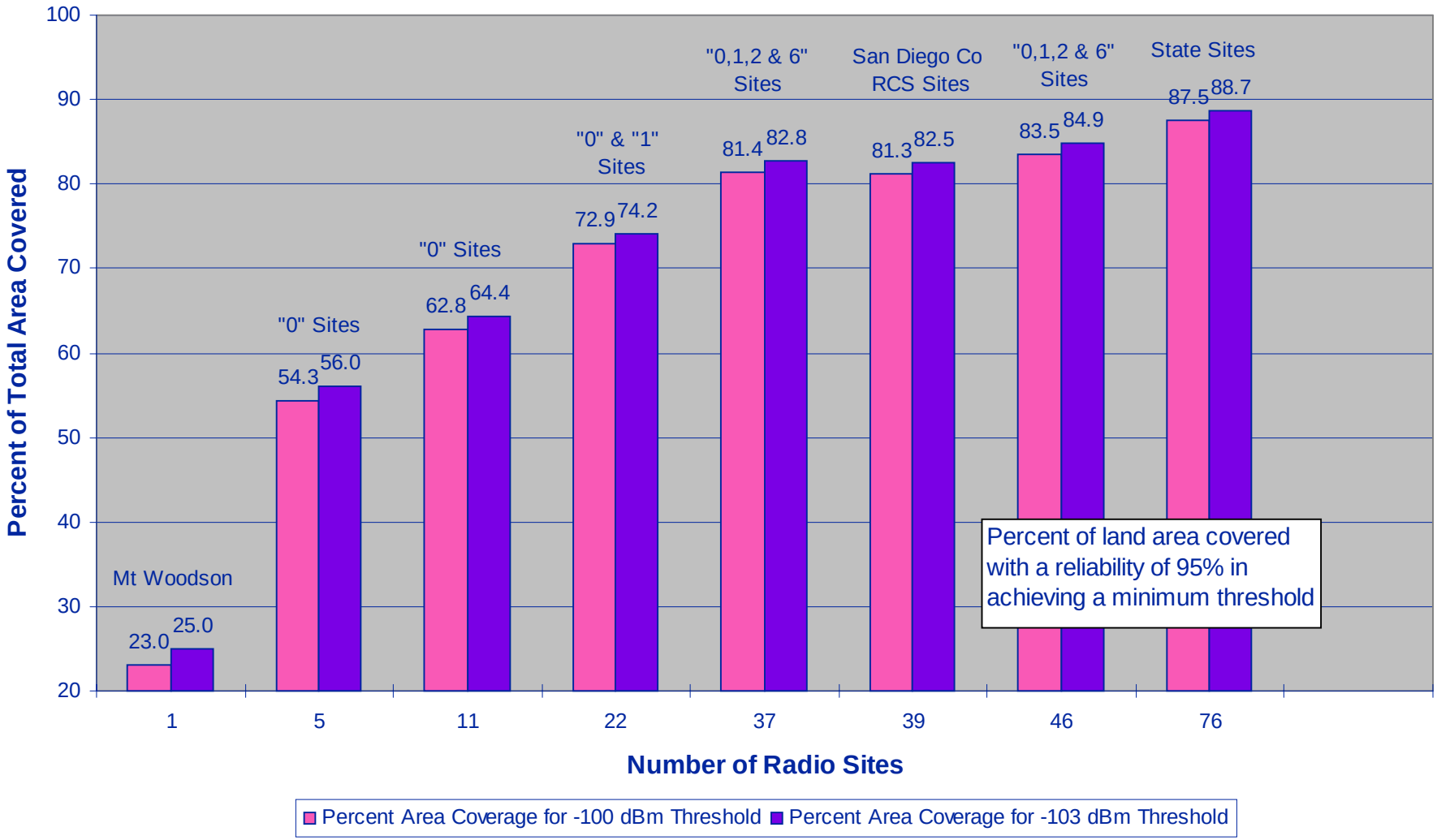
PERCENT OF AREA COVERED BY RADIO SITES
San Diego County



PERCENT OF AREA COVERED BY RADIO SITES
San Diego County



PERCENT OF AREA COVERED BY RADIO SITES
San Diego County



Coverage Area Comparison vs Frequency Band of Operation Using Nine Existing CHP Sites

- Low Band VHF
- 150 MHz Band
- 450 MHz Band
- 800 MHz Band

Comparison compensates for band peculiarities such as antenna gain limitations, man made noise limitations, et cetera

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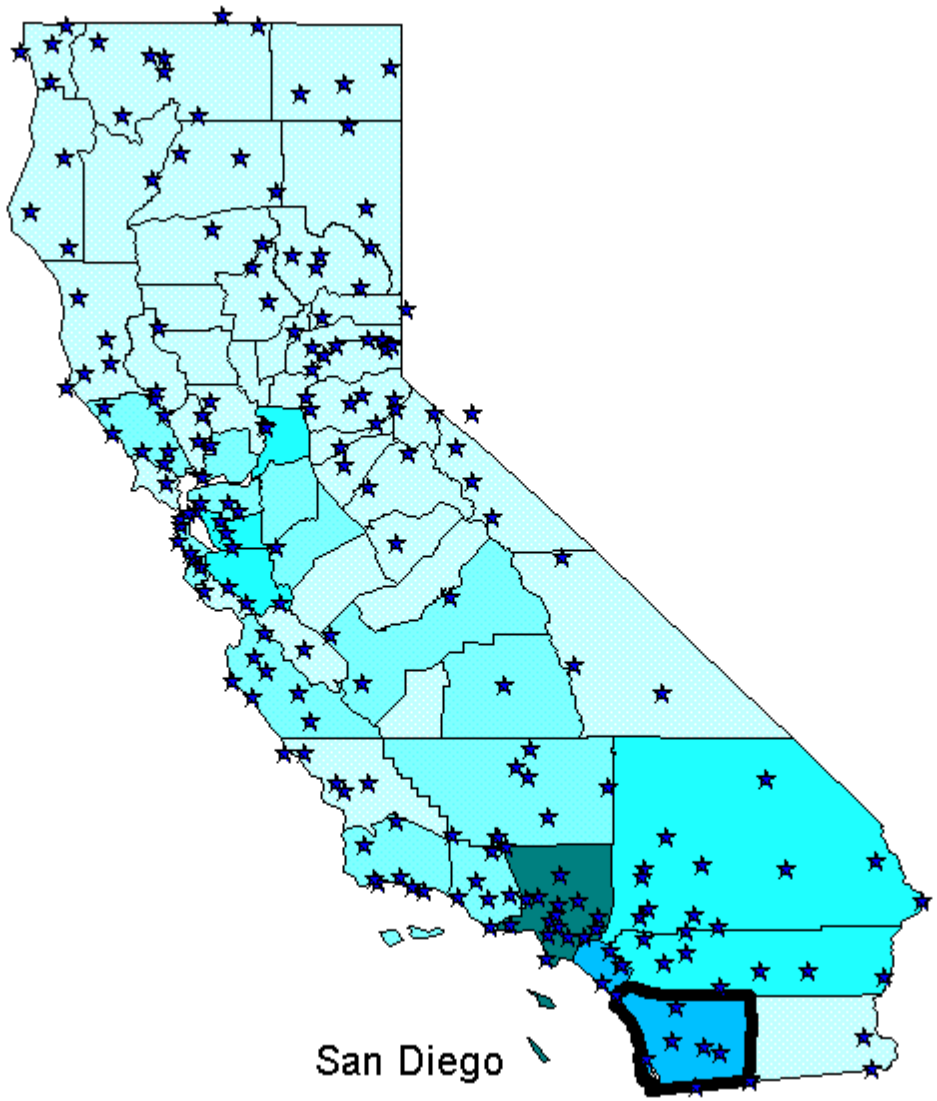

- Background colors reflects population levels.
- CHP sites indicated.

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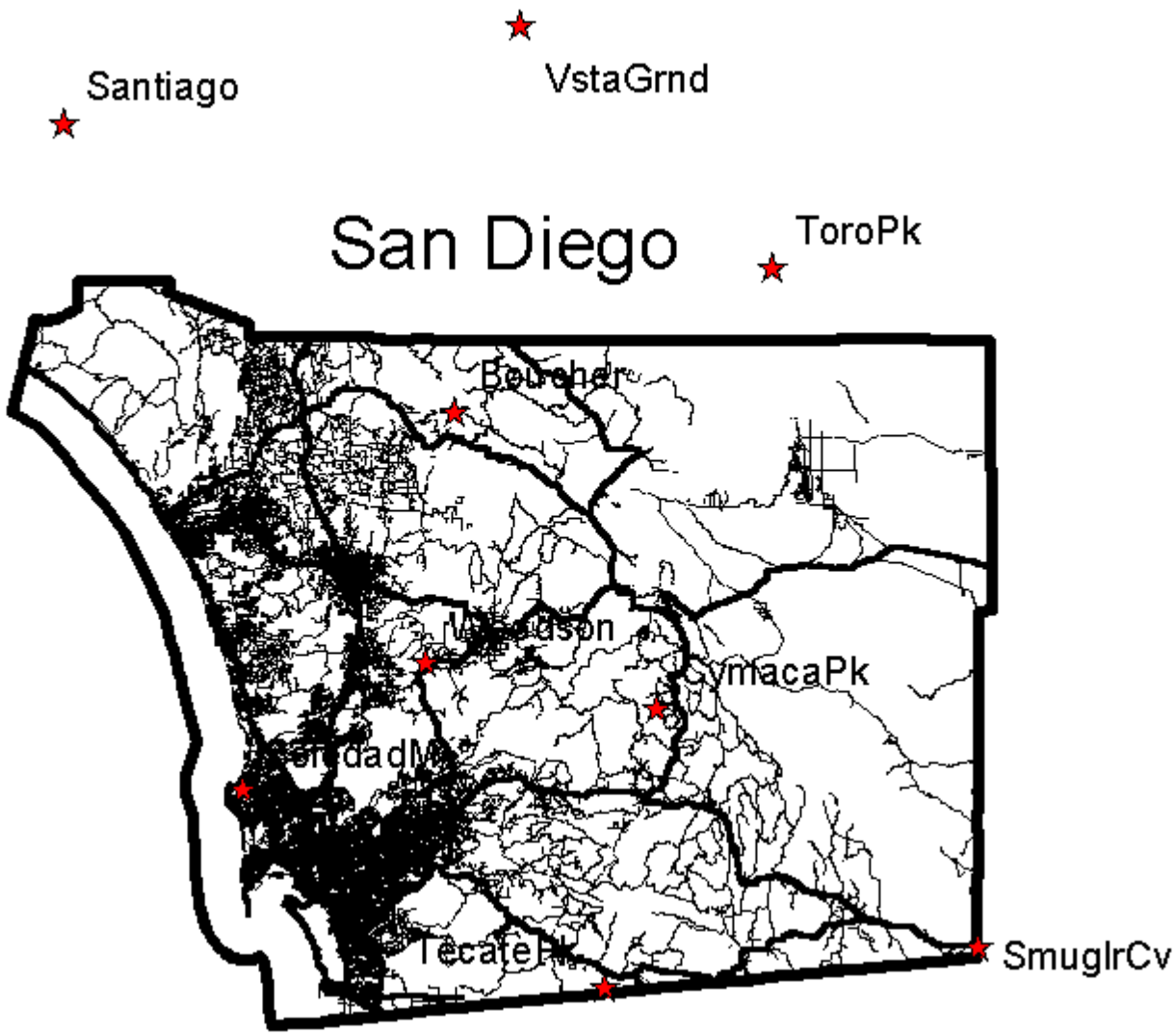

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Low Band VHF at 95% Reliability

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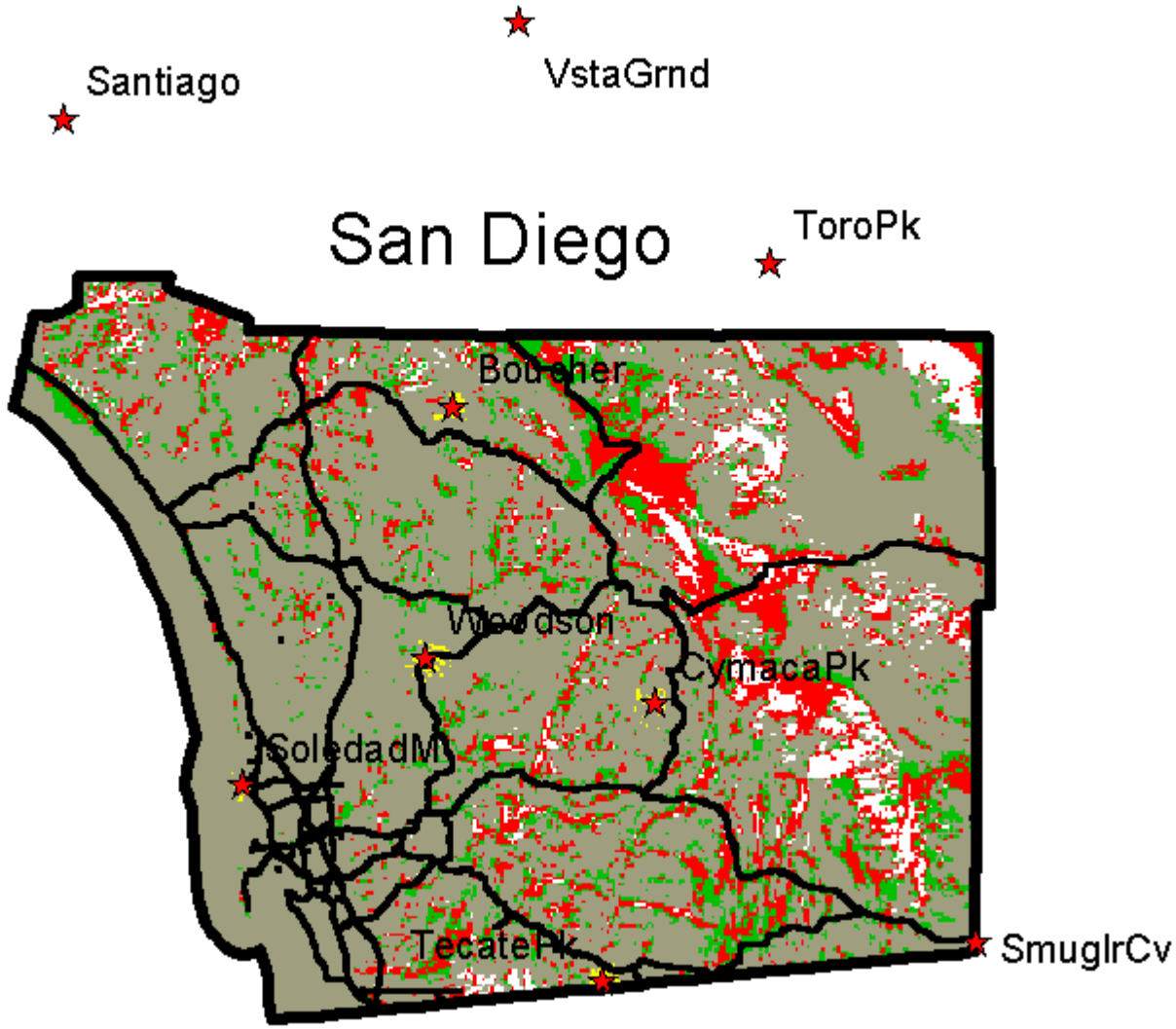

San Diego County
High Band VHF at 95% Reliability

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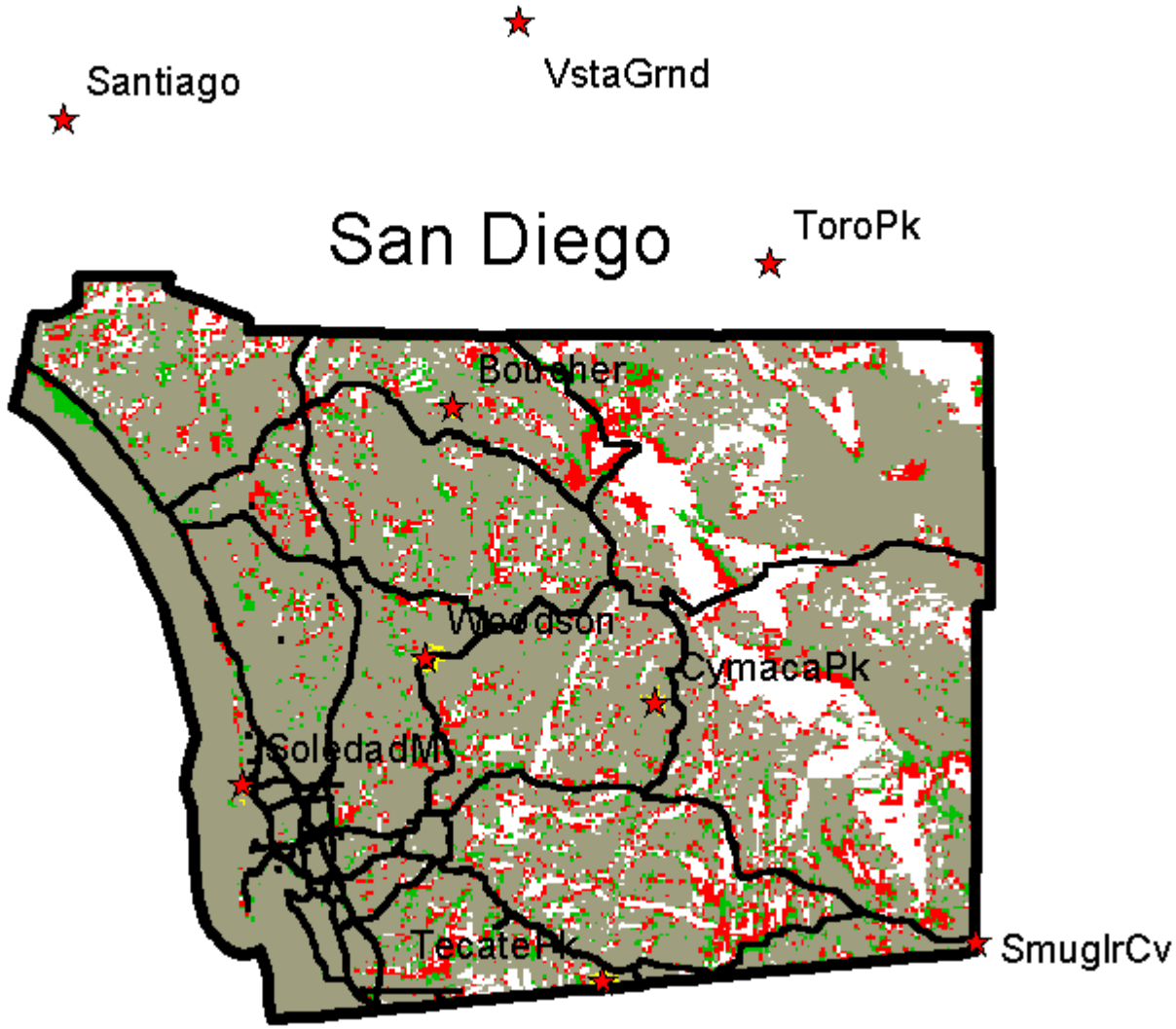

San Diego County
UHF Band at 95% Reliability

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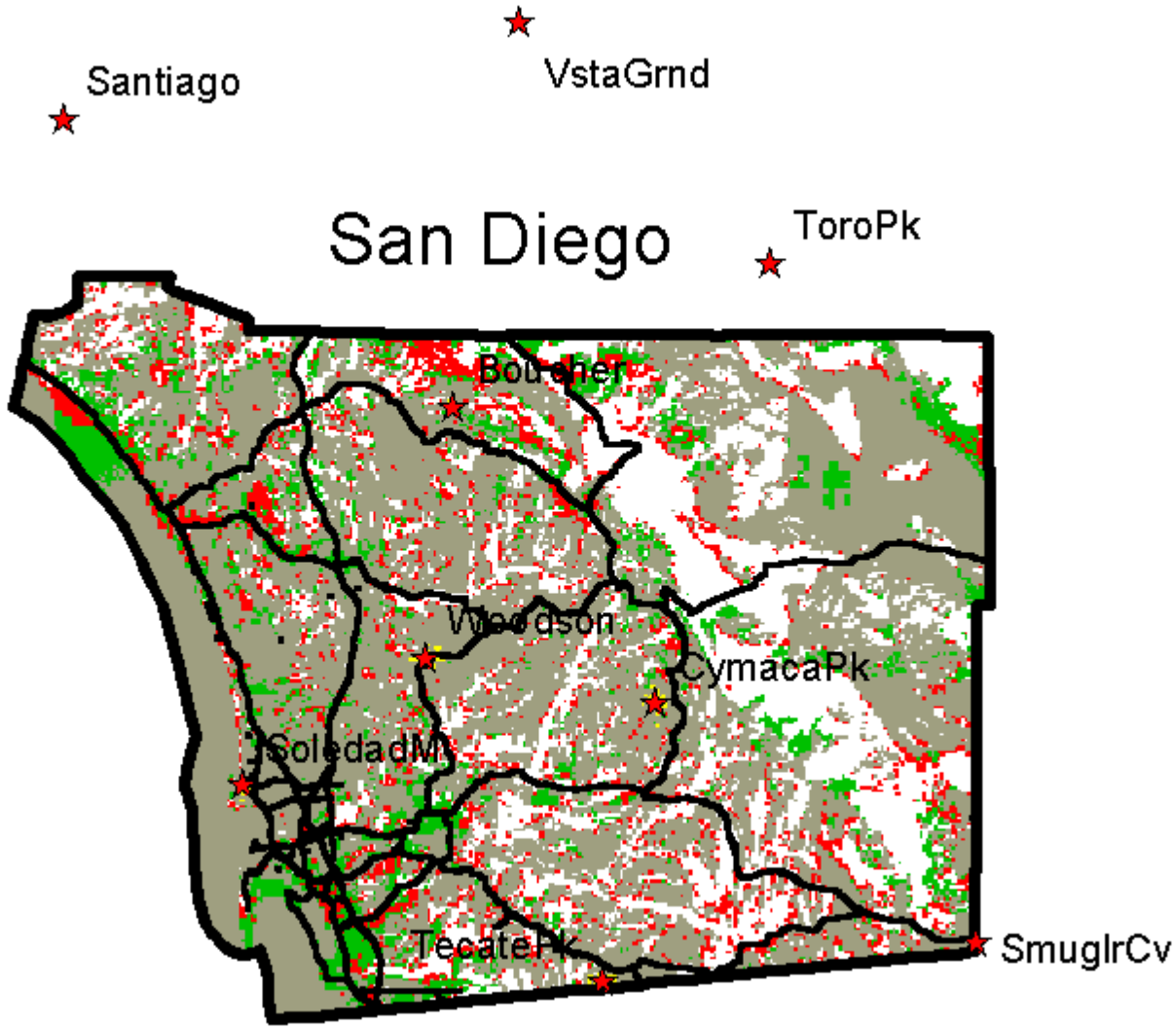

San Diego County
800 MHz Band at 95% Reliability

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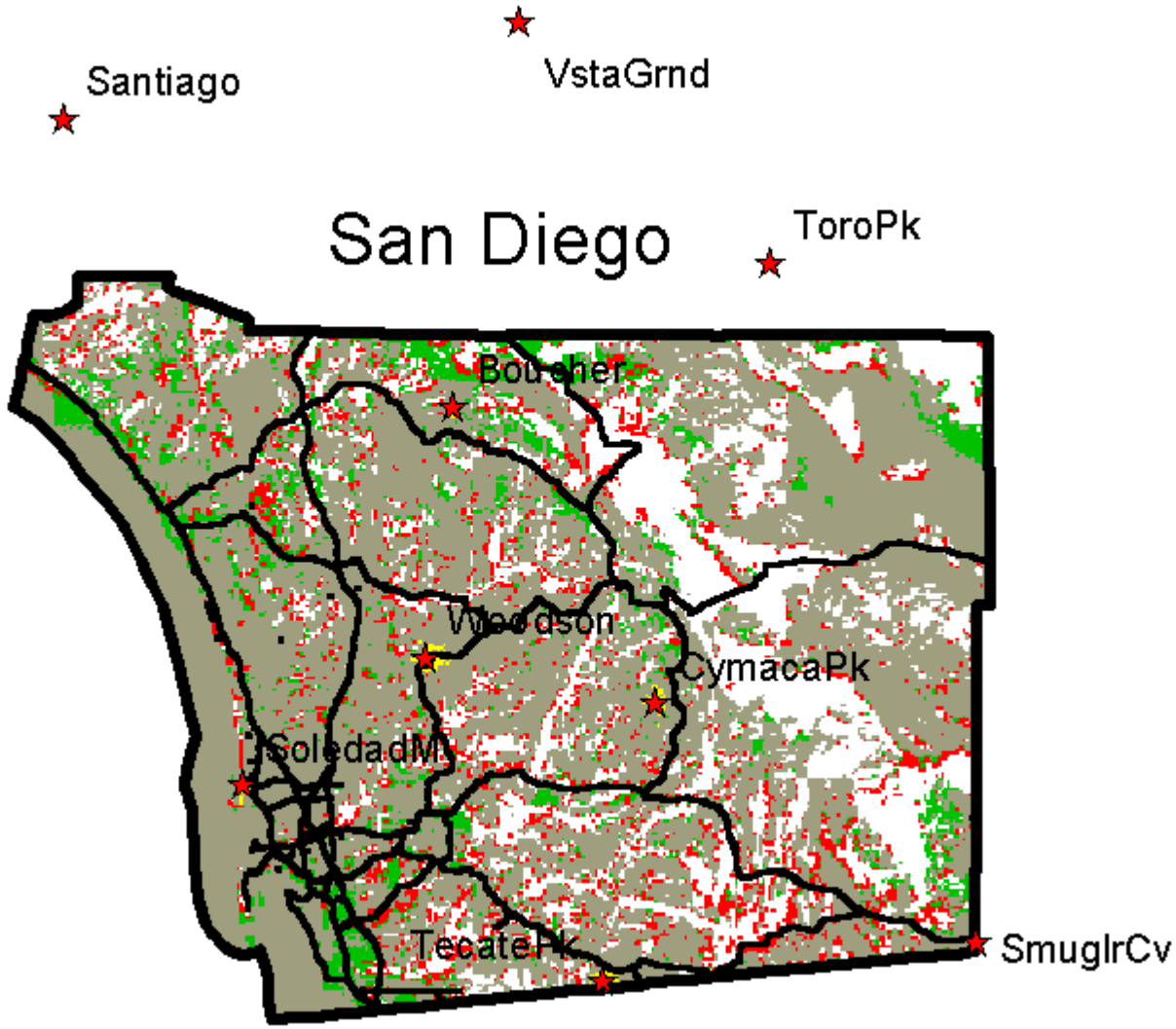
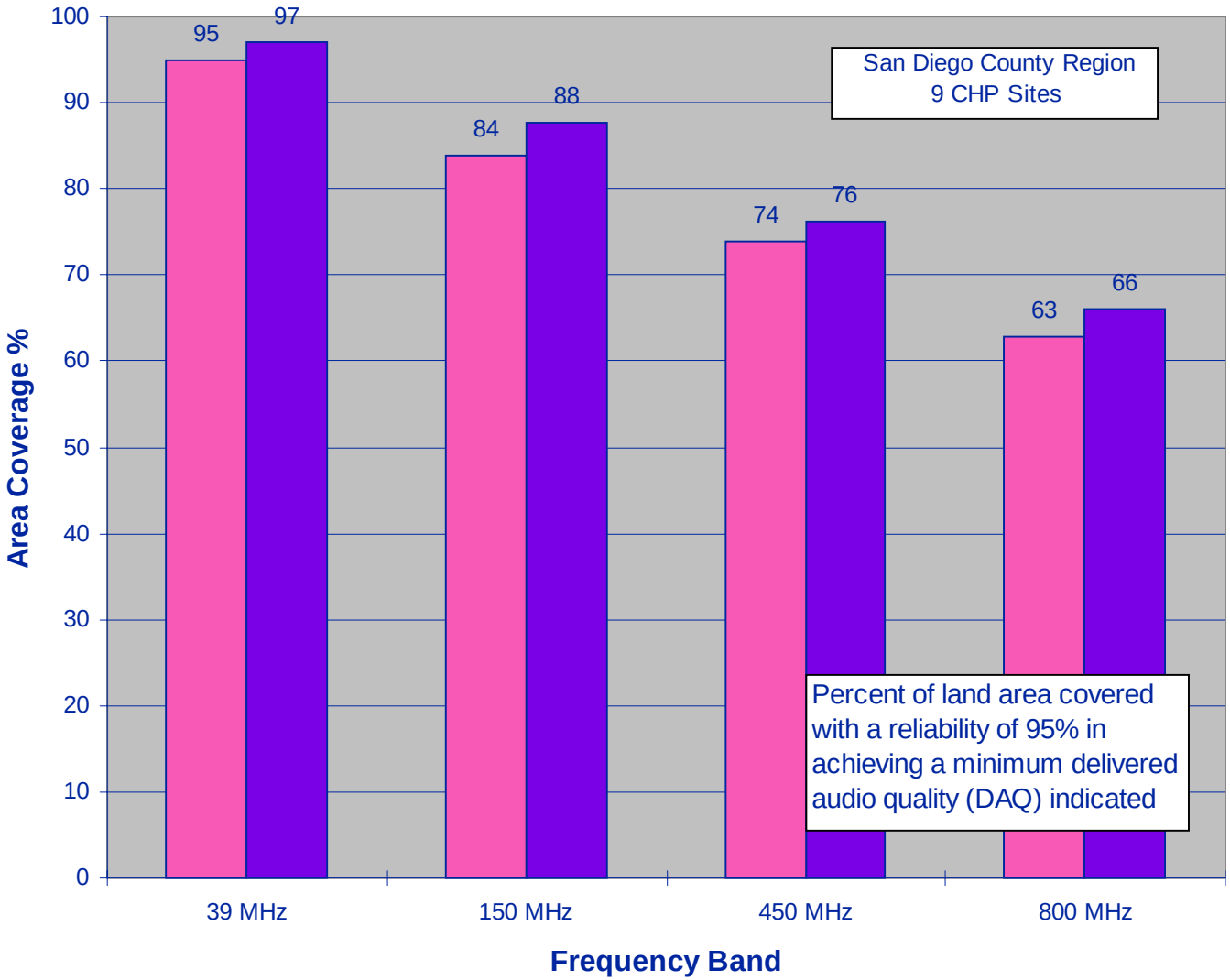


San Diego County
800 MHz Band at 90% Reliability

RELATIVE AREA COVERAGE COMPARISON VERSUS FREQUENCY BAND
Typical Antenna System Limitations per Band



Degrading effects of noise at two lower frequency bands are reflected for the suburban case

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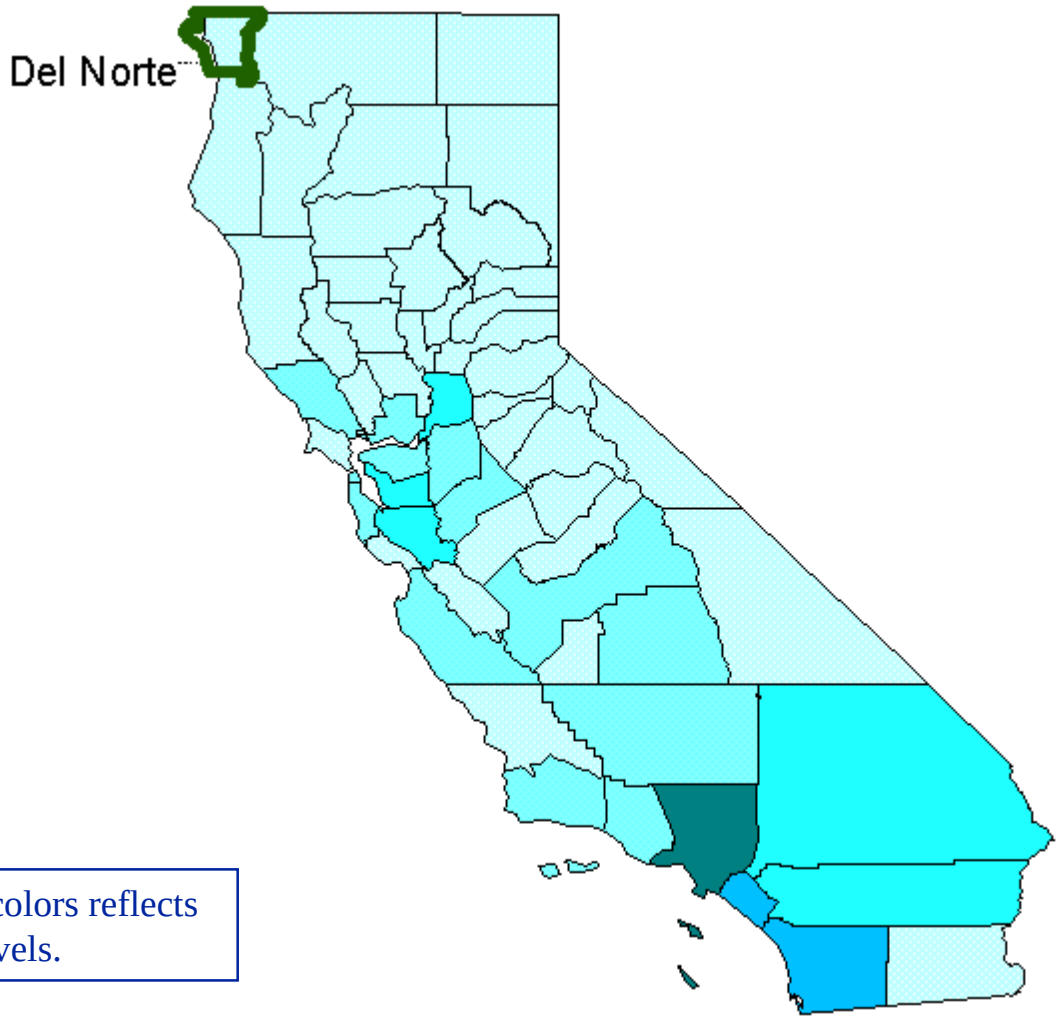

Background colors reflects population levels.

Del Norte County

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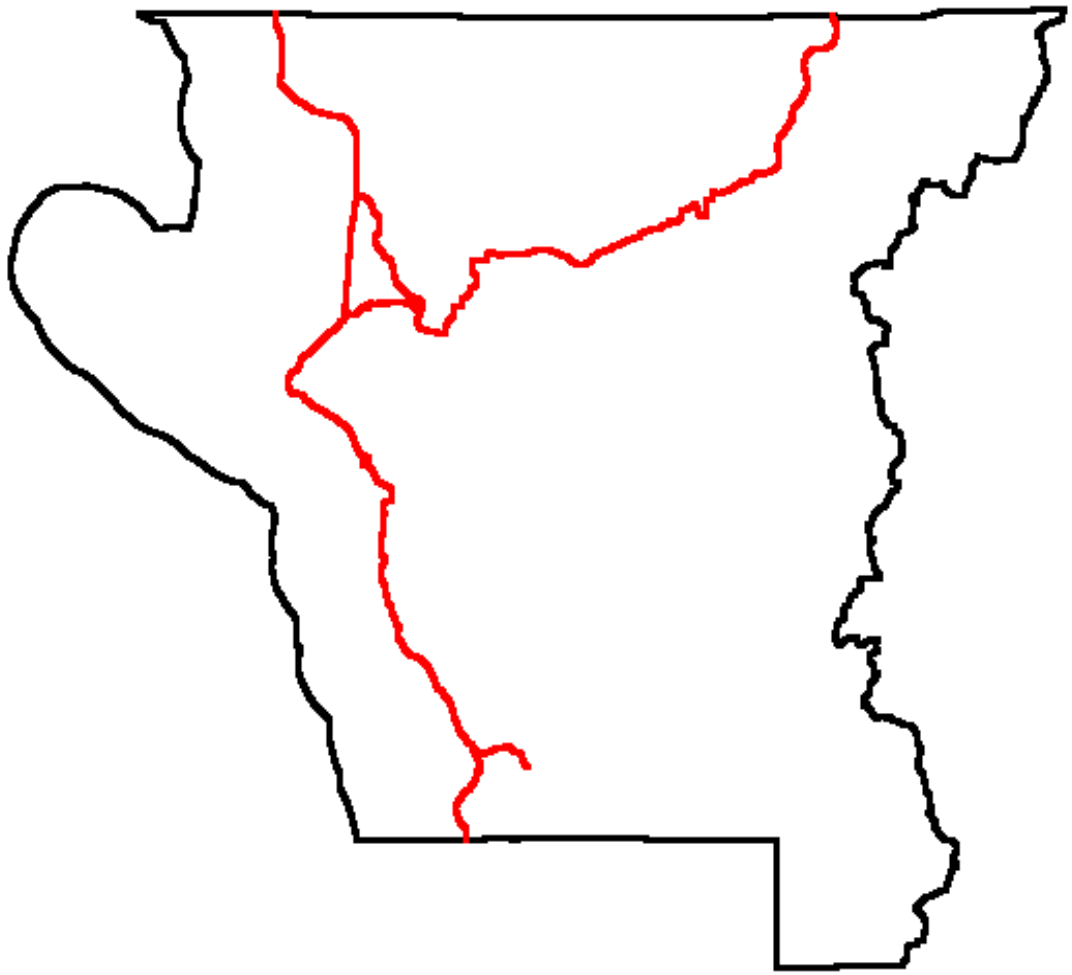

Del Norte County - Primary Roads

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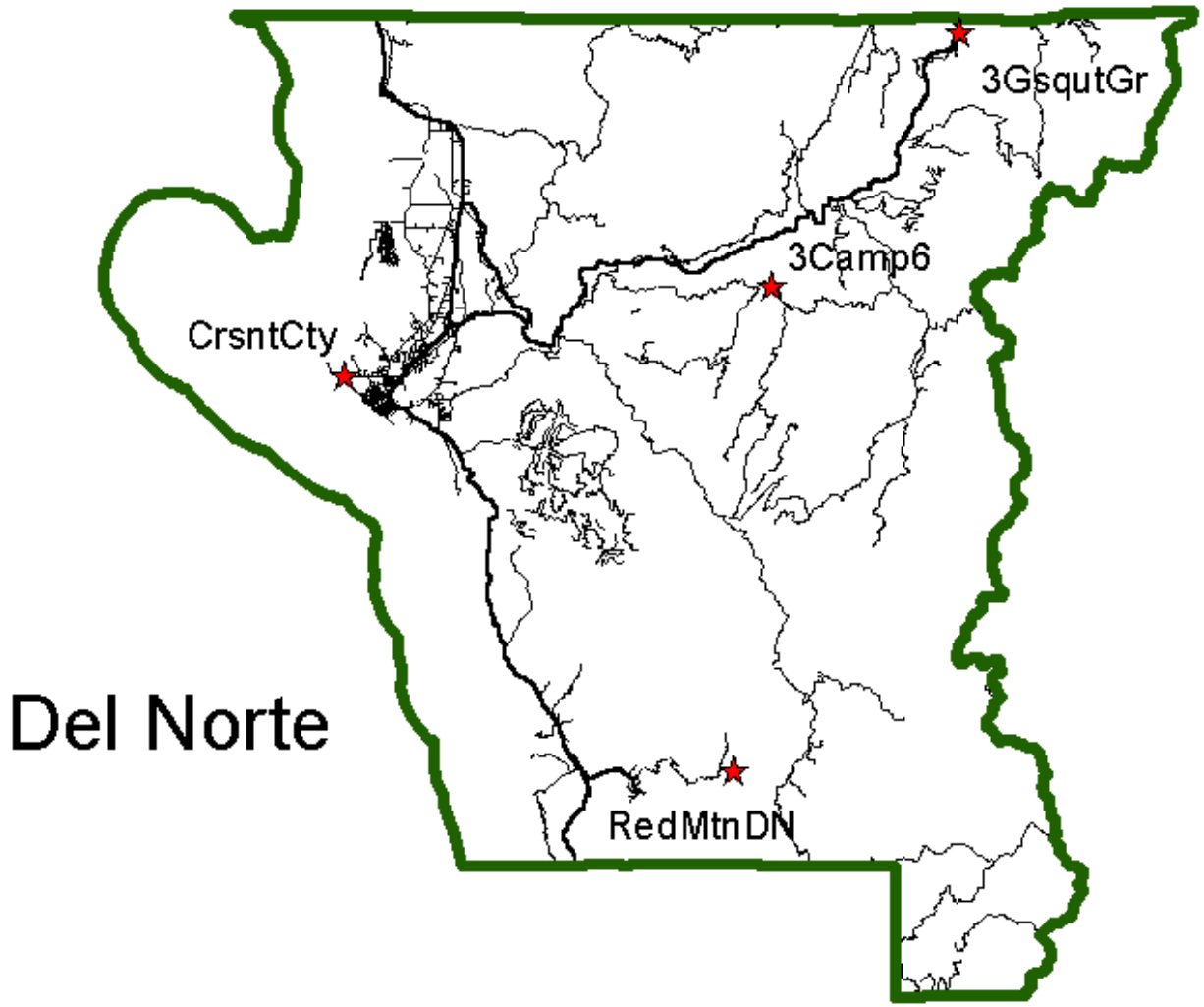

Del Norte County - Primary & Secondary Roads

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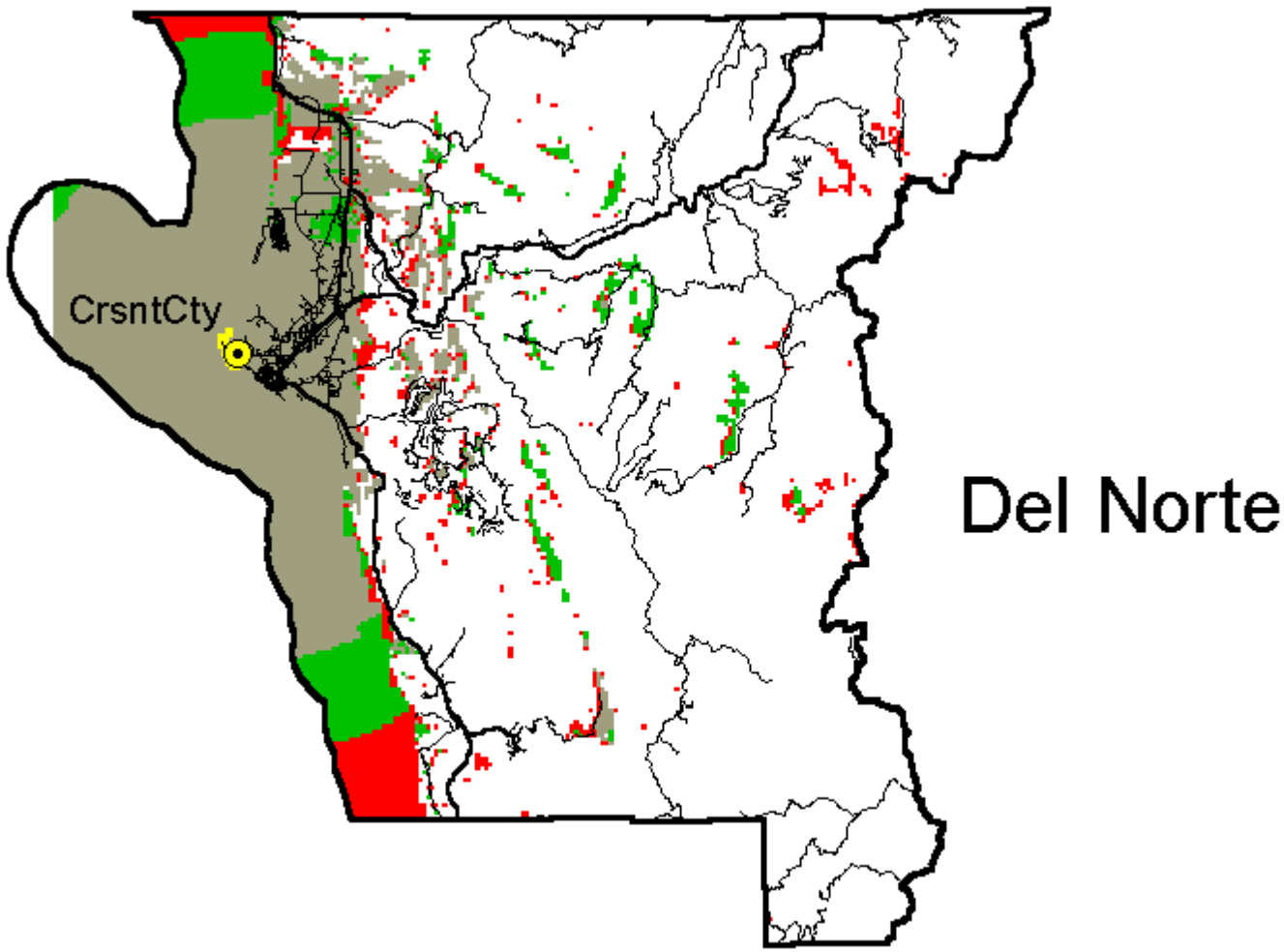

Del Norte County Coverage - 1 Site Example

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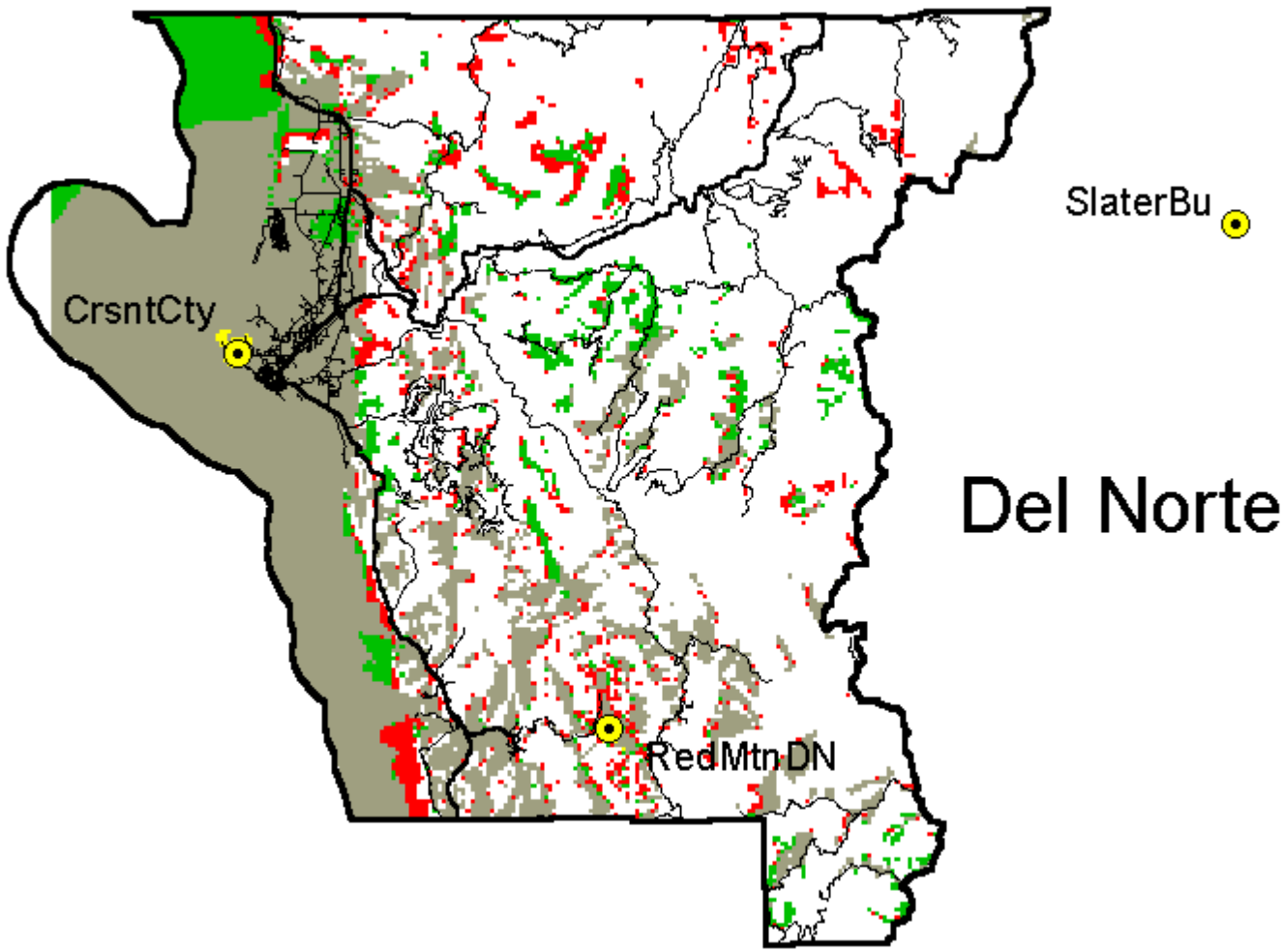

Del Norte County Coverage - 3 Site Example

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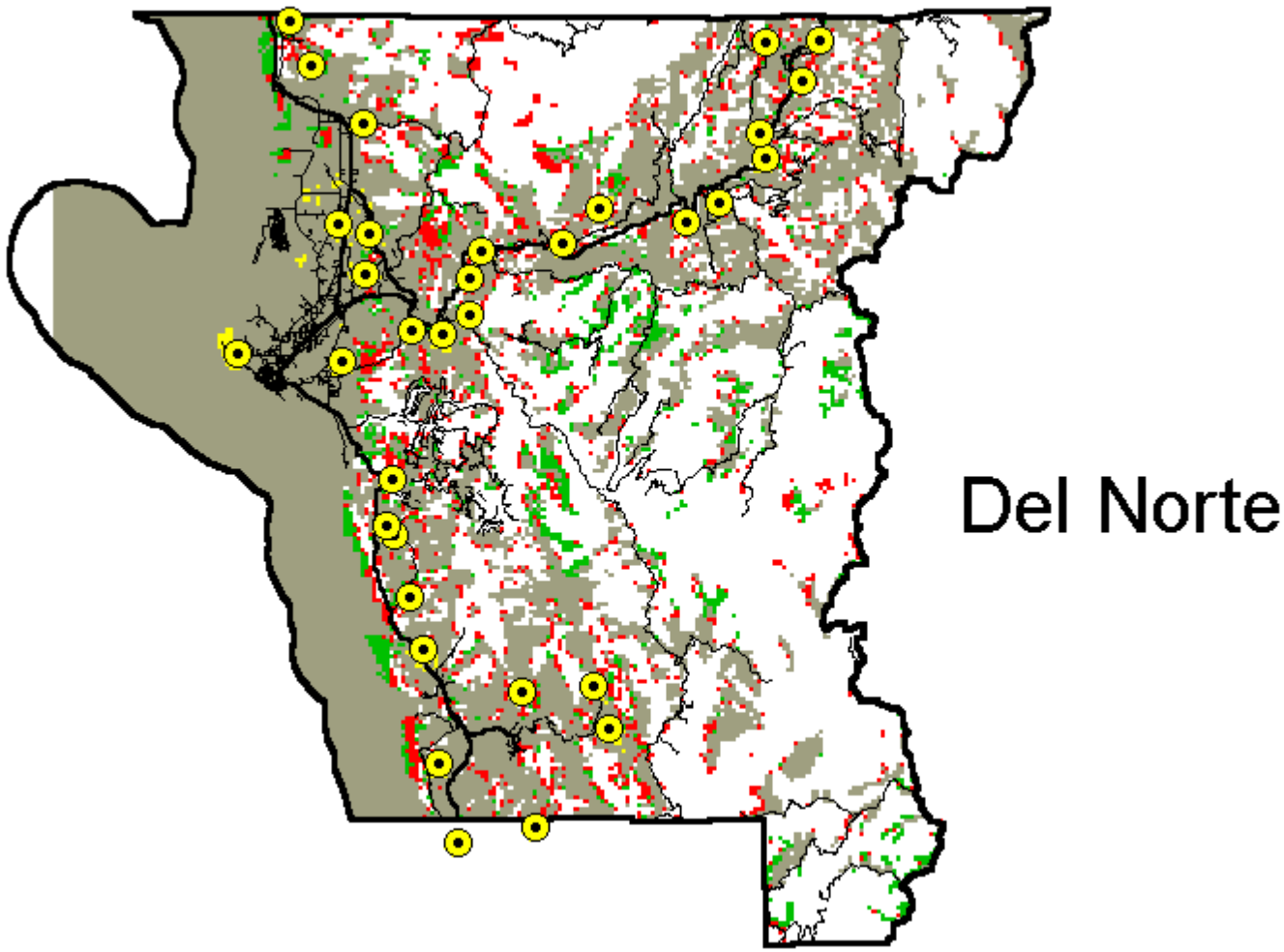

Del Norte County Coverage - 33 Site Example

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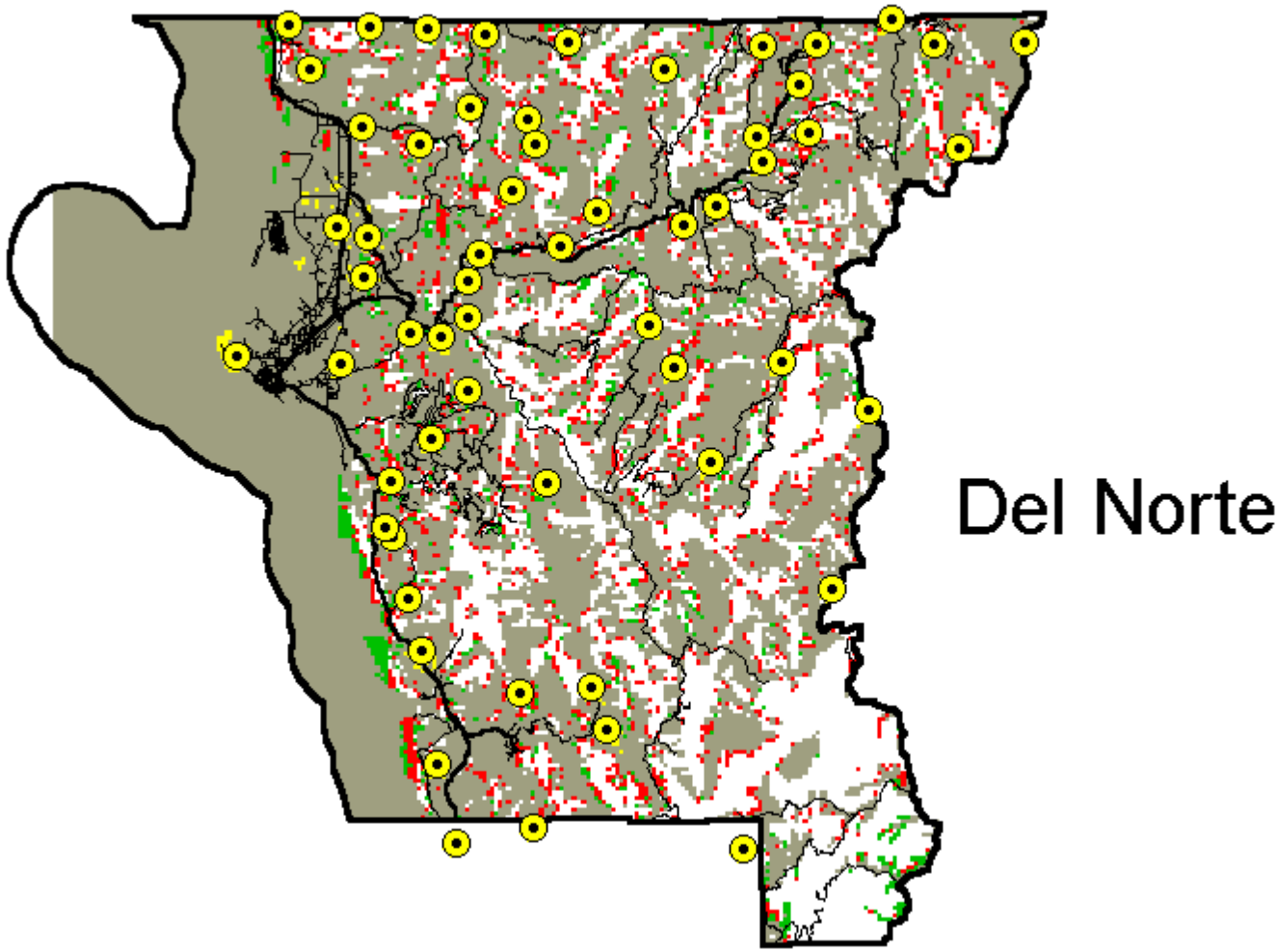

Del Norte County Coverage - 58 Site Example

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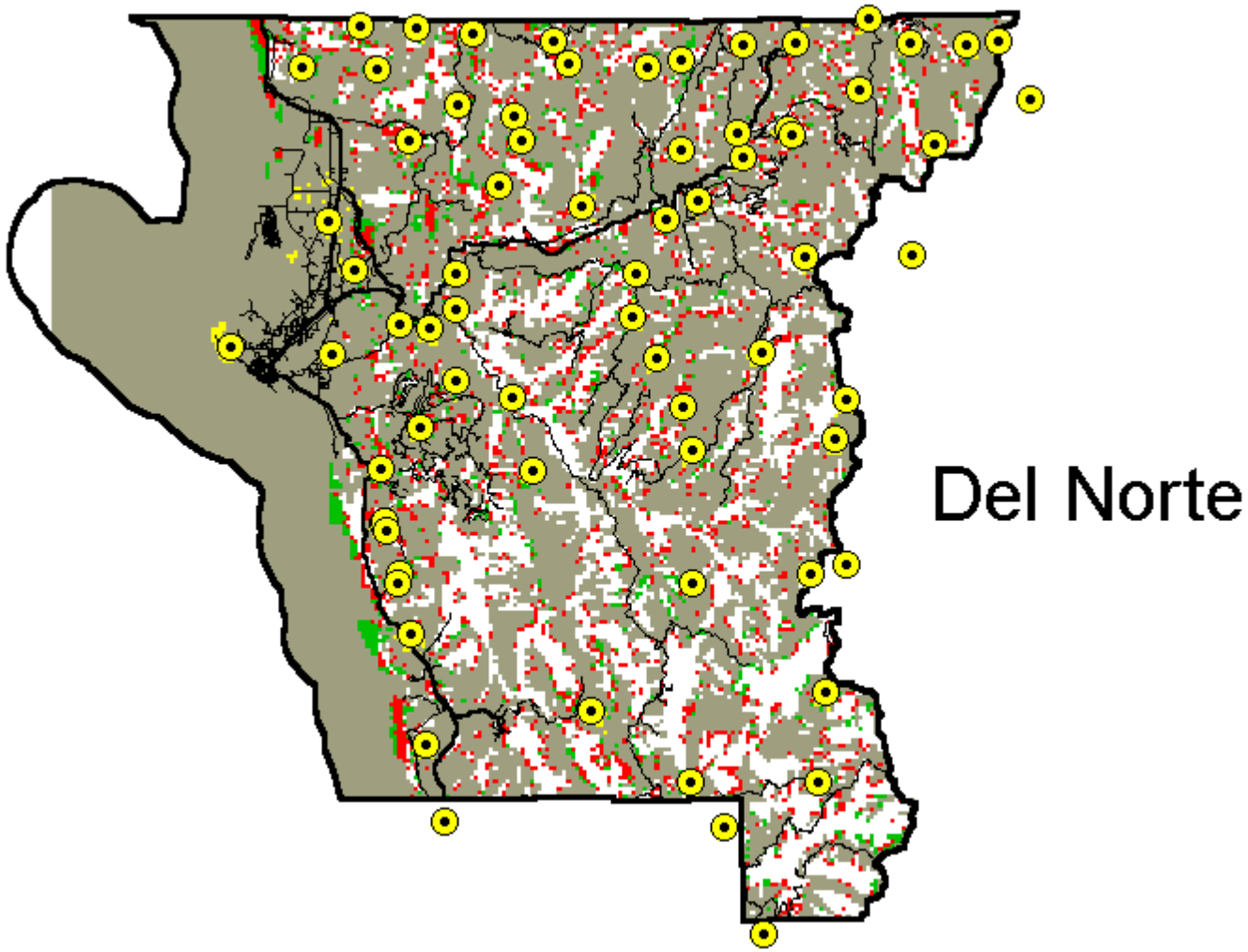
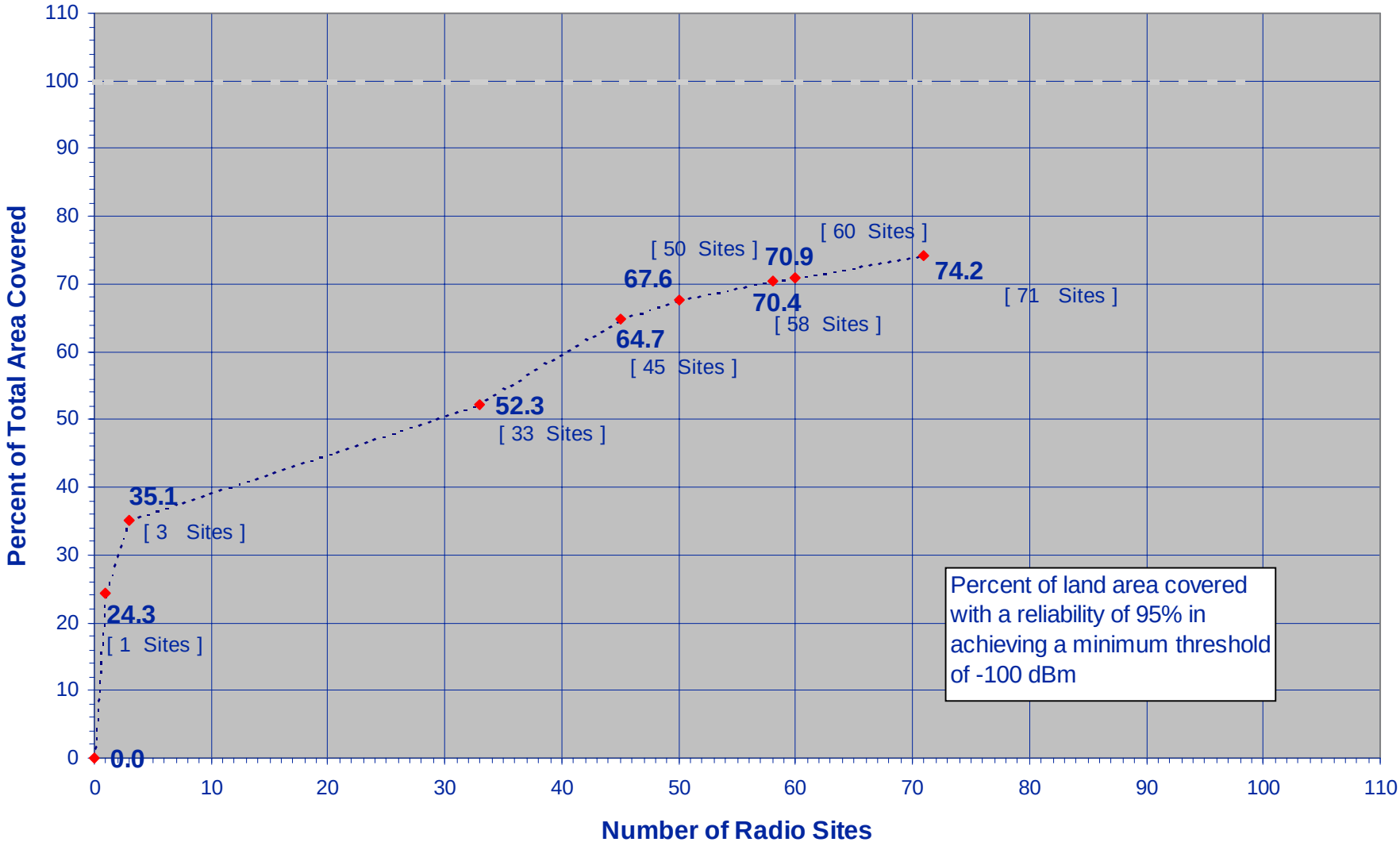


Del Norte County Coverage - 71 Site Example

PERCENT OF AREA COVERED BY RADIO SITES
Del Norte County



Coverage Area Comparison vs Frequency Band of Operation Using Four Existing CHP Sites

- Low Band VHF
- 150 MHz Band
- 450 MHz Band
- 800 MHz Band

Comparison compensates for band peculiarities such as antenna gain limitations, man made noise limitations, et cetera

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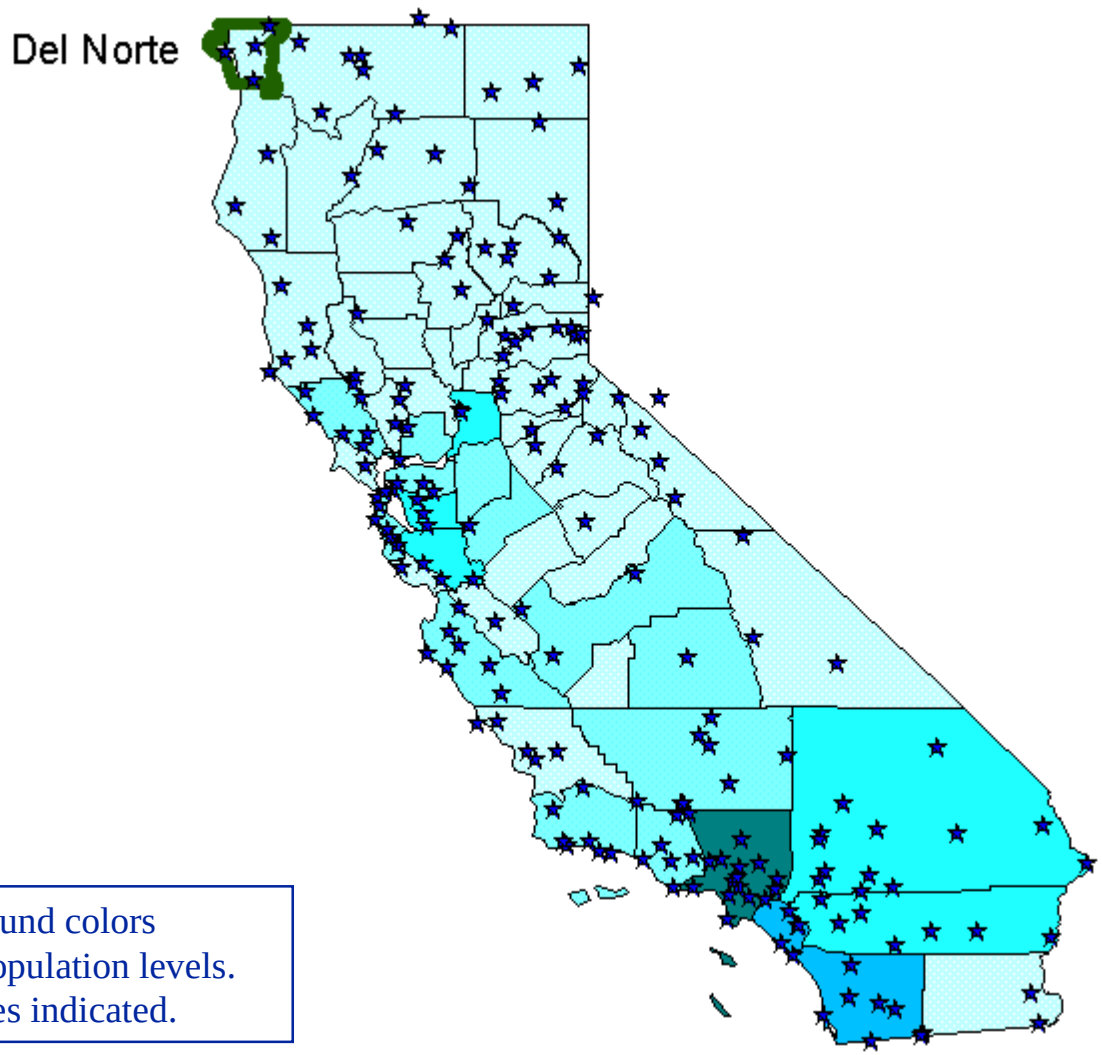

- Background colors reflects population levels.
- CHP sites indicated.

Del Norte County

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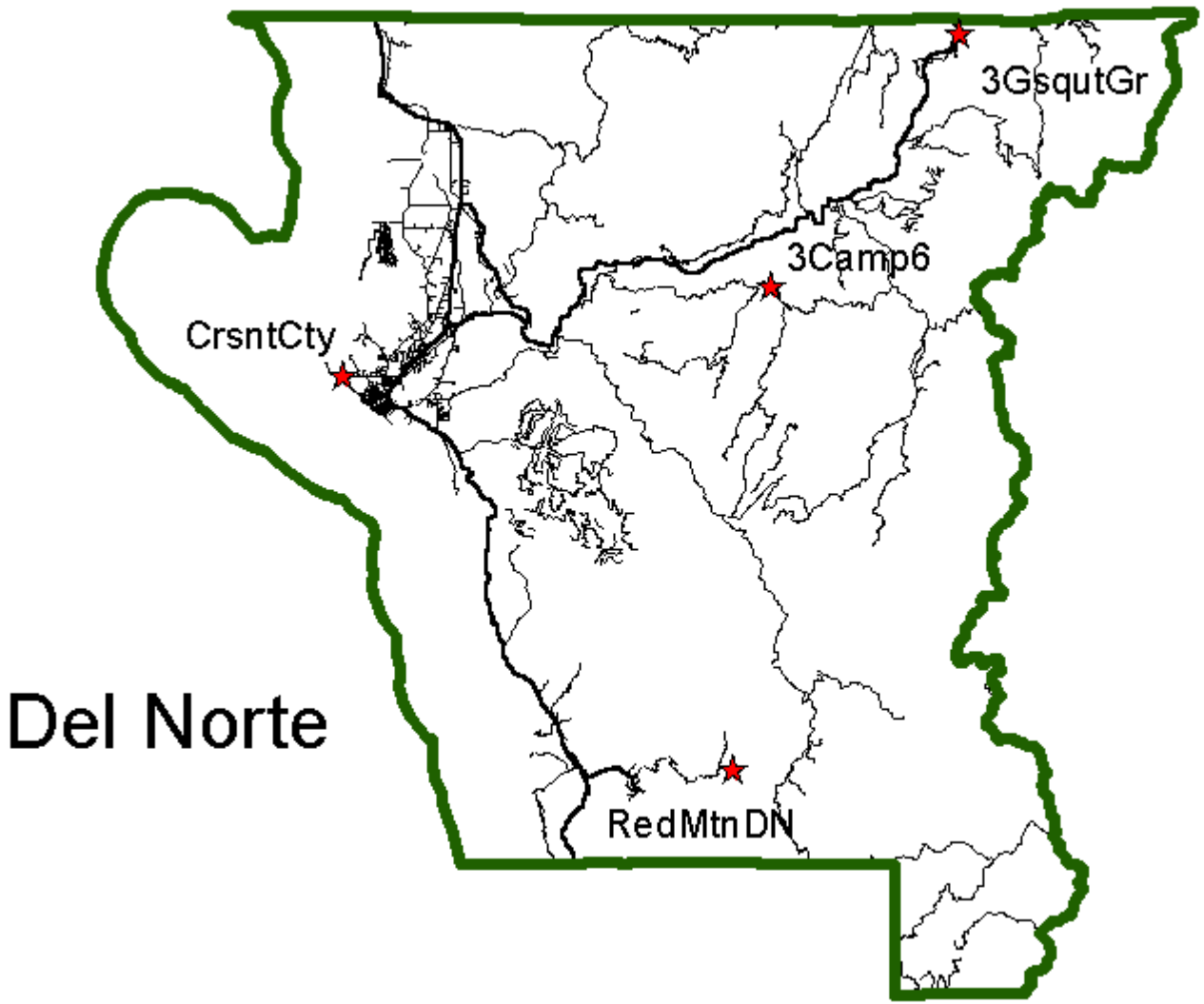
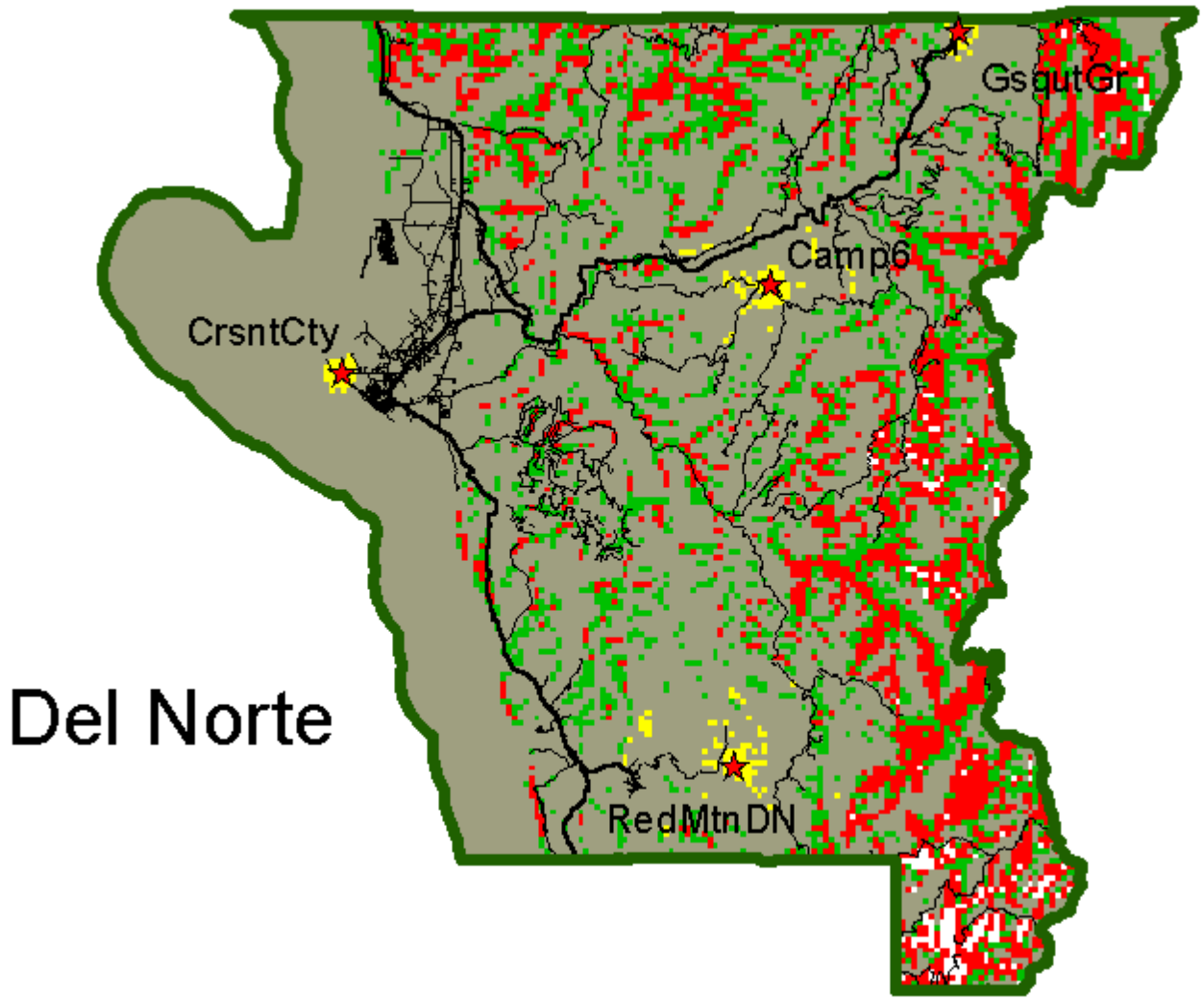
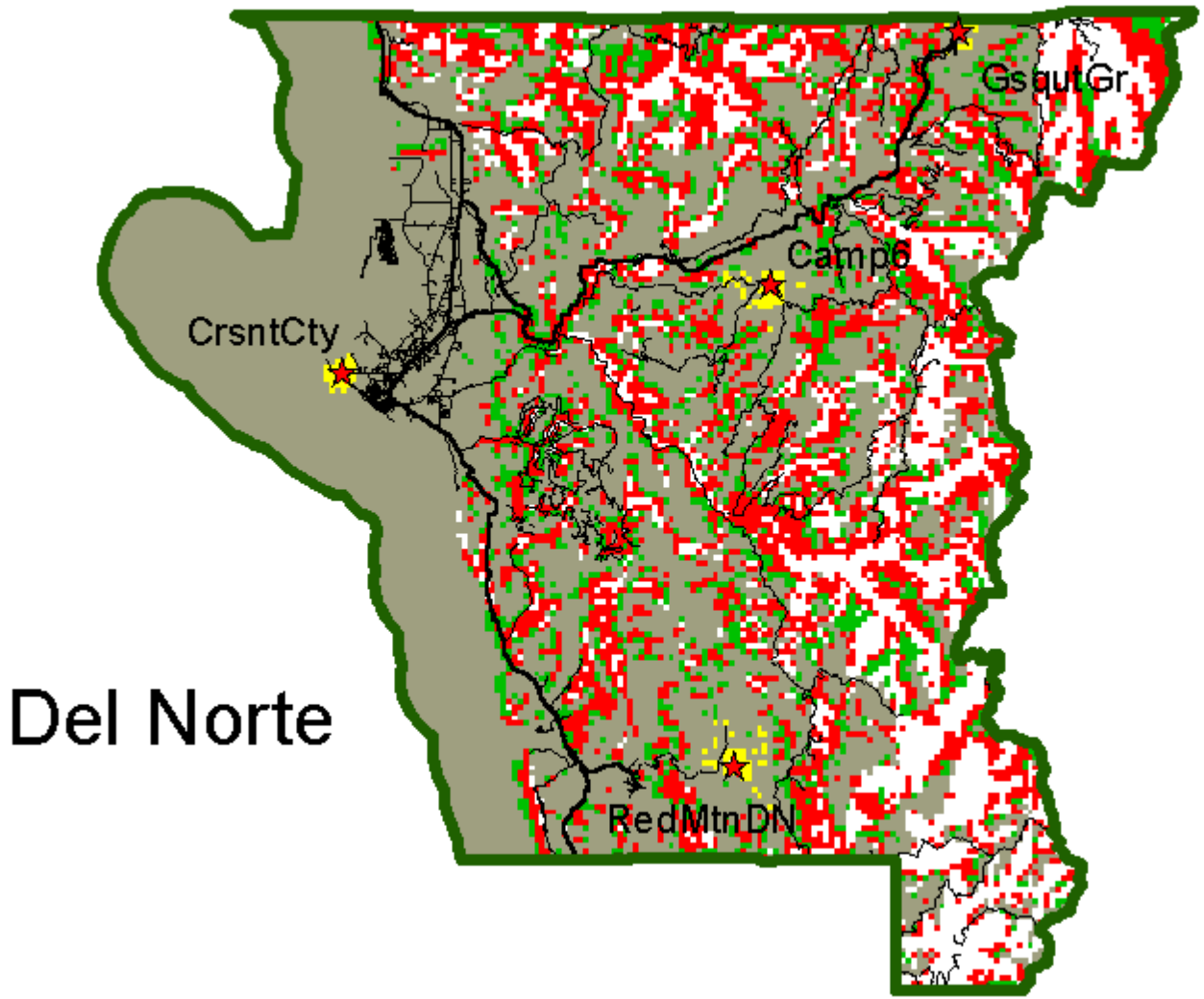


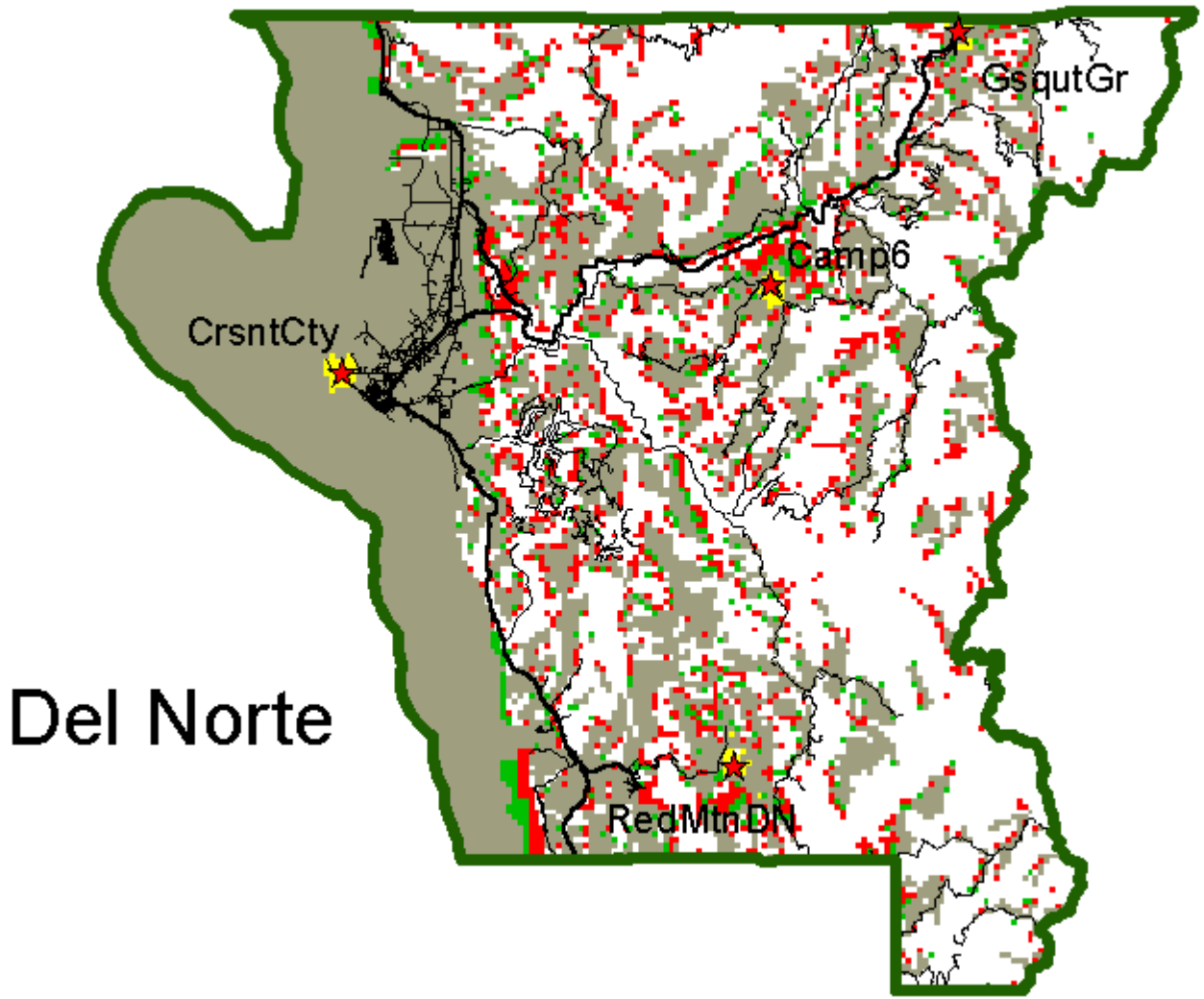
Del Norte County - Primary & Secondary Roads



Del Norte County
Low Band VHF at 95% Reliability



Del Norte County
High Band VHF at 95% Reliability



Del Norte County
UHF Band at 95% Reliability

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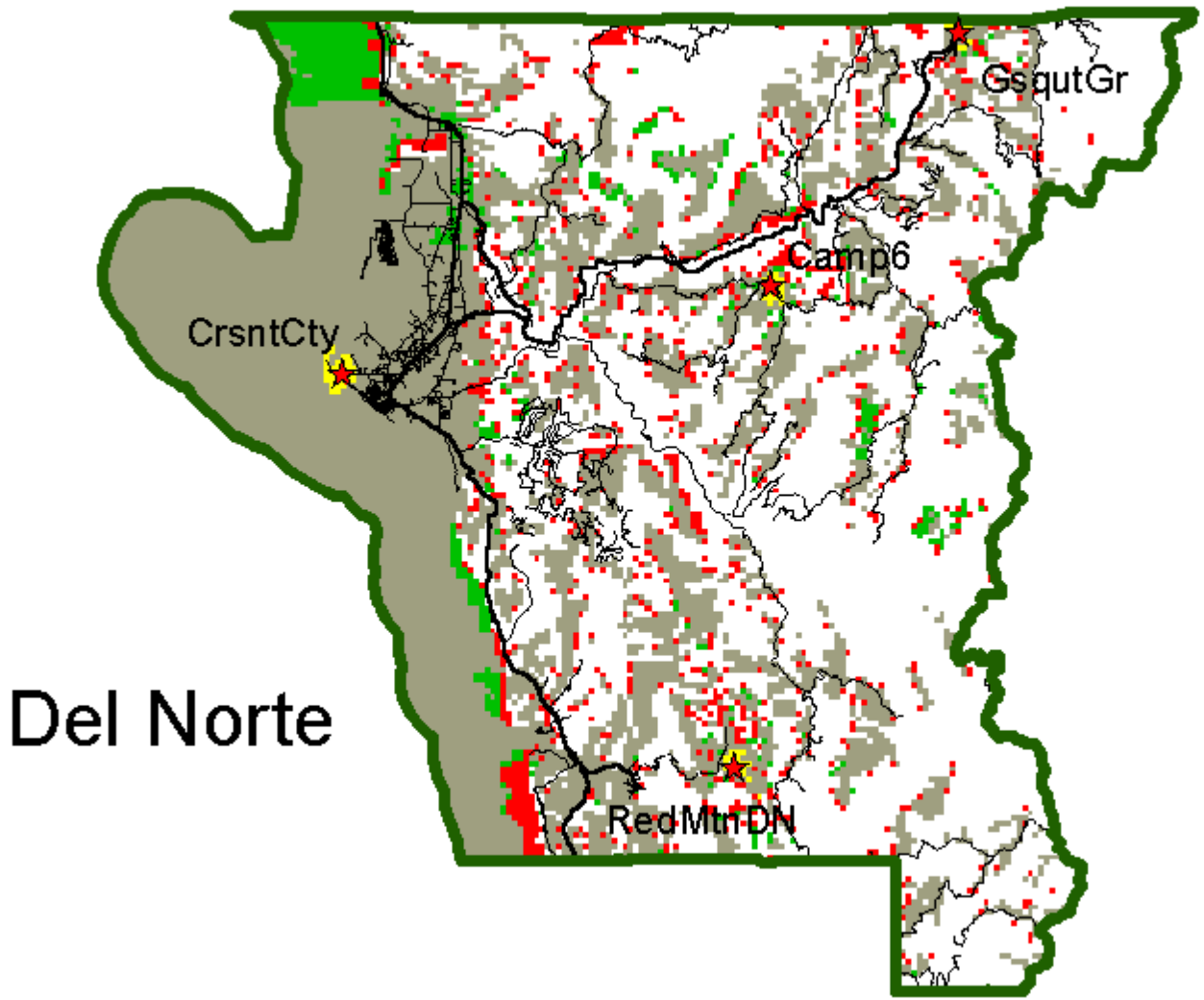

Del Norte County
800 MHz Band at 95% Reliability

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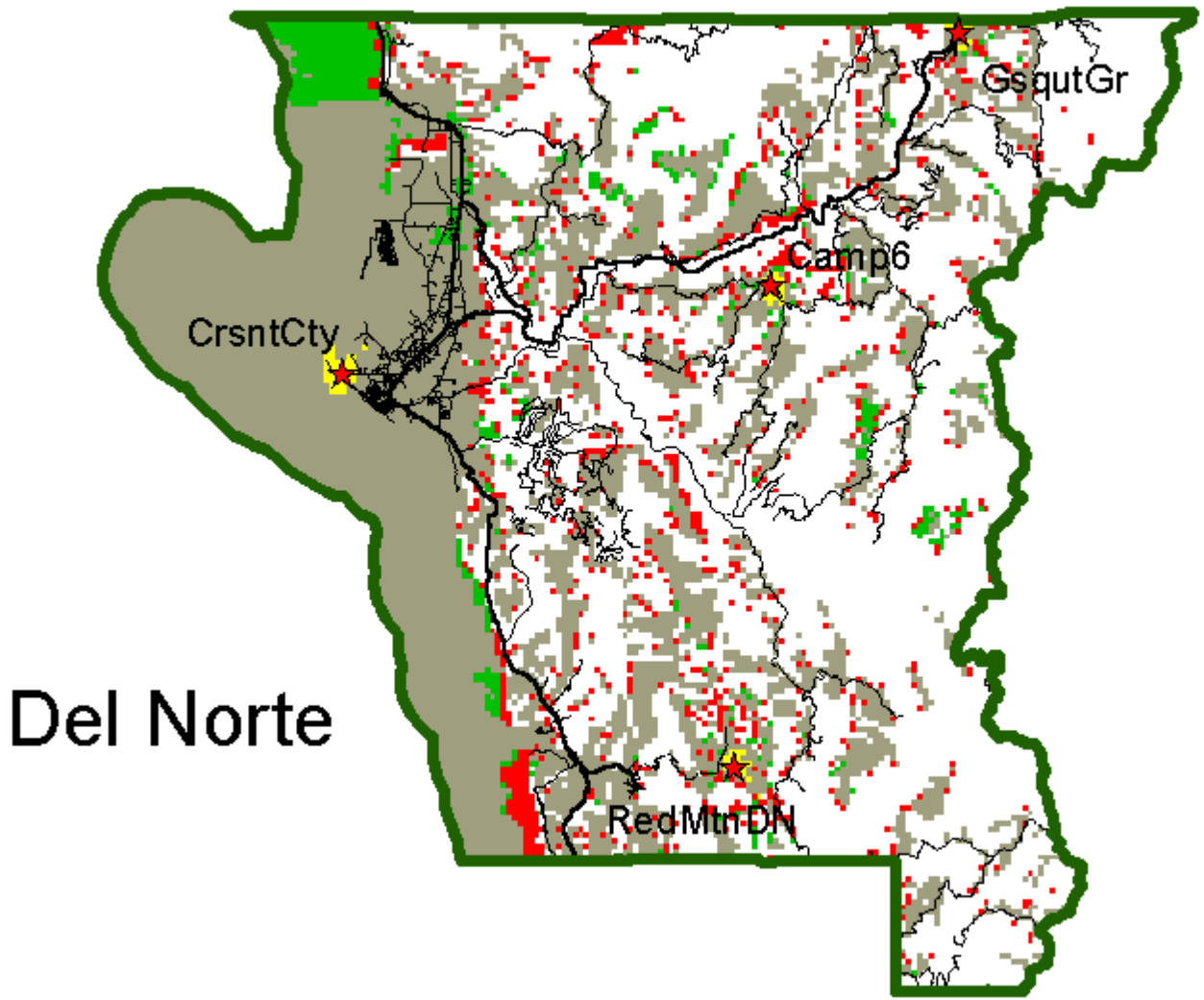
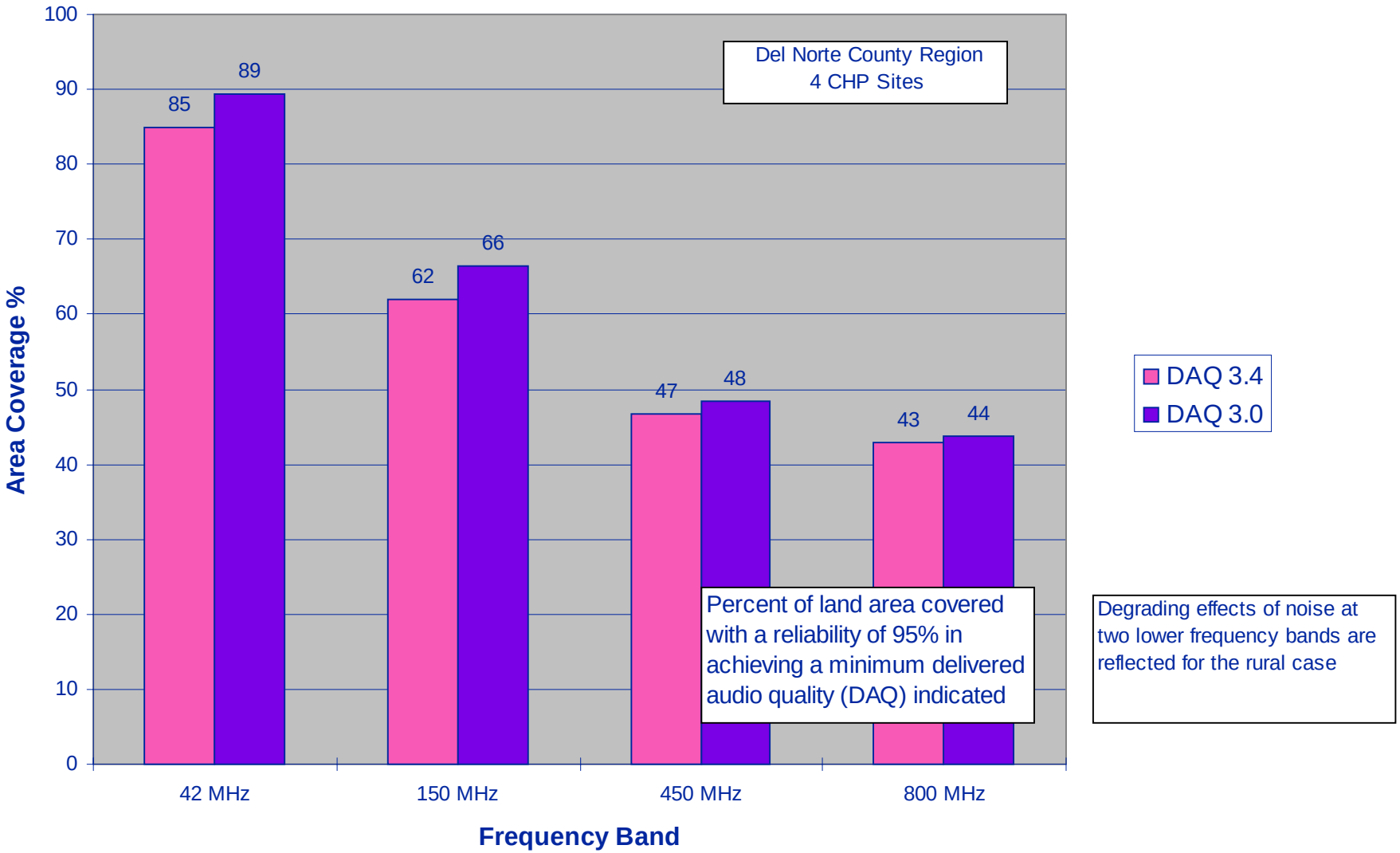


Del Norte County
800 MHz Band at 90% Reliability

RELATIVE AREA COVERAGE COMPARISON VERSUS FREQUENCY BAND
Typical Antenna System Limitations per Band



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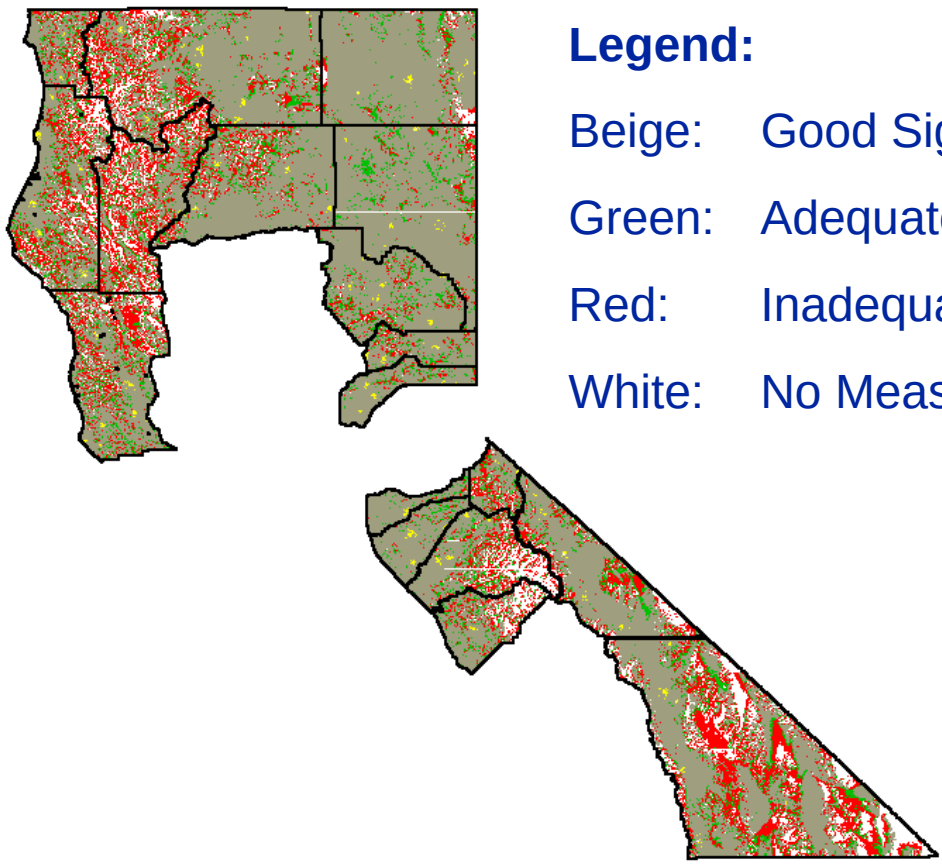
150 MHz SYSTEM COVERAGE IN AFFECTED COUNTIES



Legend:

Beige: Good Signal Strength

Green: Adequate Signal Strength

Red: Inadequate Signal Strength

White: No Measurable Signal

Tentative VHF HB Areas

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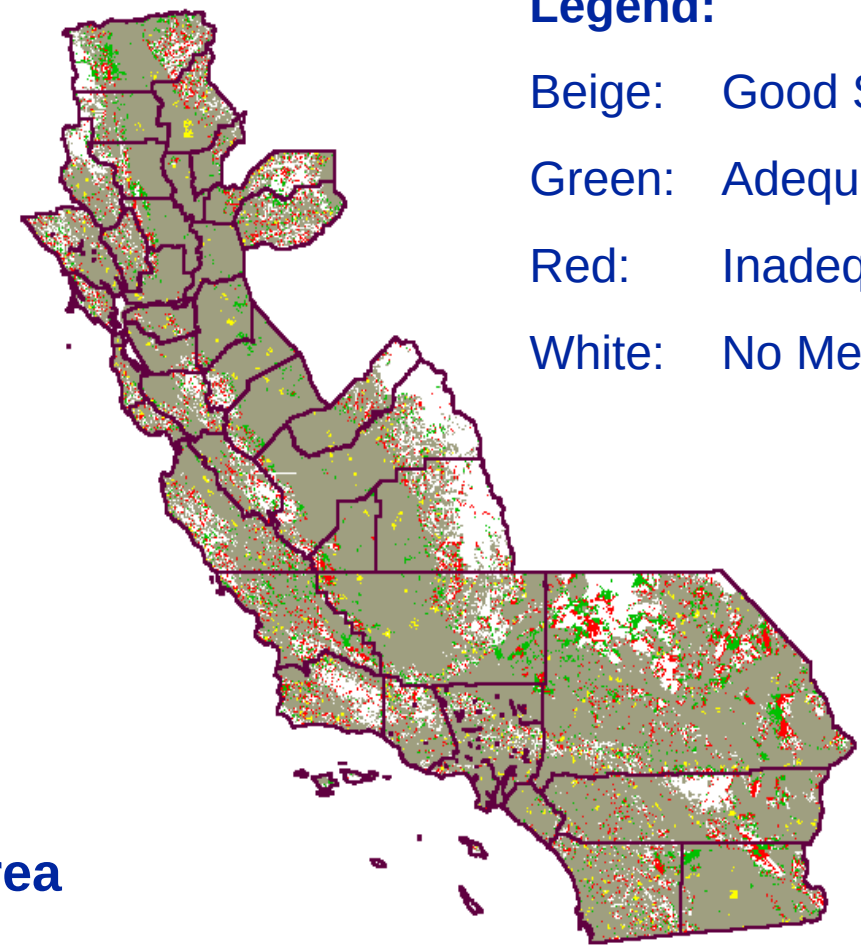
800 MHz SYSTEM COVERAGE IN AFFECTED COUNTIES



Legend:

Beige: Good Signal Strength

Green: Adequate Signal Strength

Red: Inadequate Signal Strength

White: No Measurable Signal

Tentative UHF Area

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CANDIDATE PHASE I PROJECT AREAS

- The initial deployment will be scrutinized to validate assumptions and concepts prior to statewide deployment.
- Two candidate areas under consideration for initial deployment
  - Sacramento Valley Project Area
  - Central Valley Project Area

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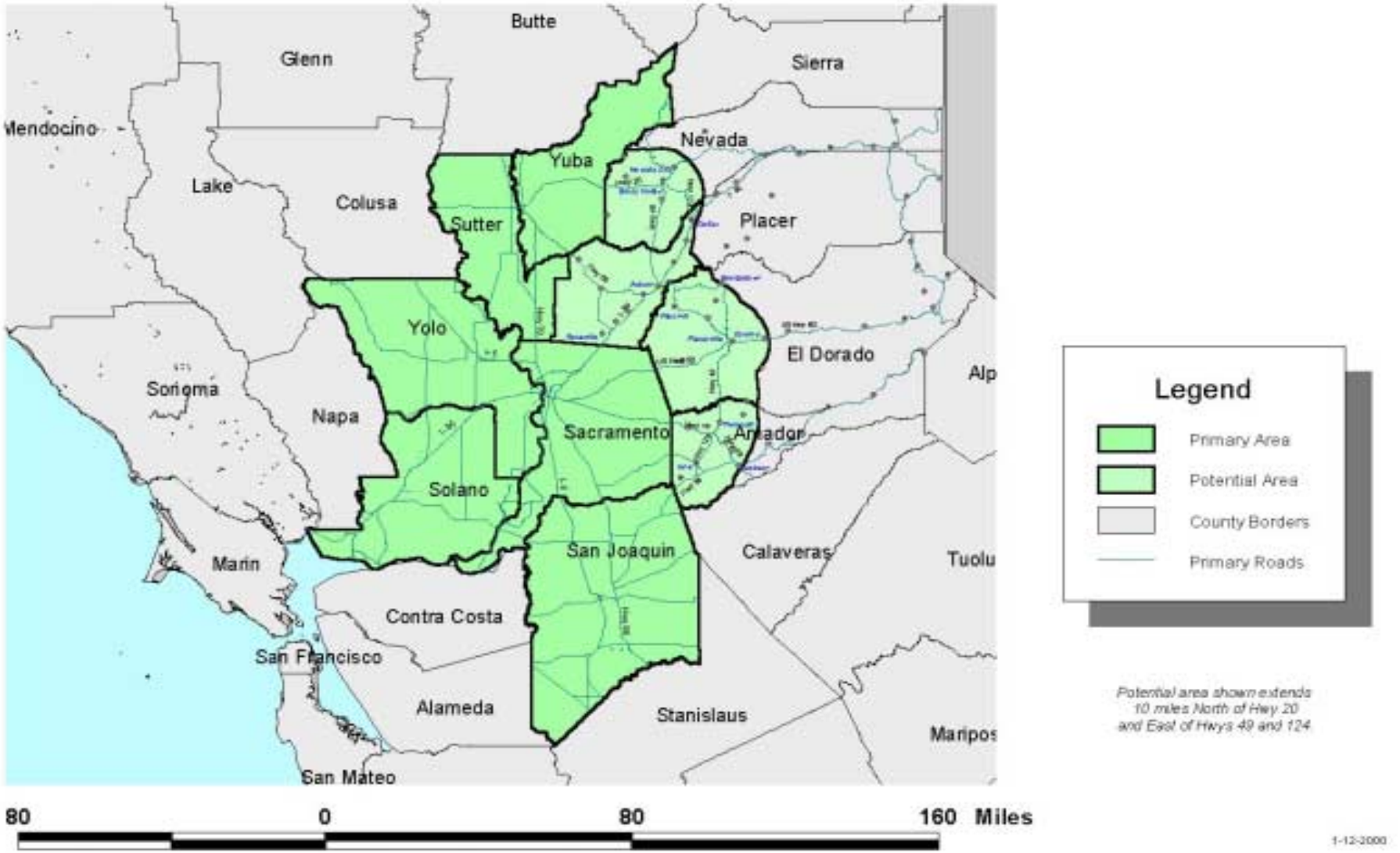
SACRAMENTO PHASE I PROJECT AREA

- Will comprise all, or some subset of, six full counties and four partial county (≤ 7,100 mi^2)

- Comparable in area to the aggregate of the Hawaiian Islands at 6,459 mi^2, or the combination of Connecticut at 5,544 mi^2 and adjacent Rhode Island at 1,231 mi^2

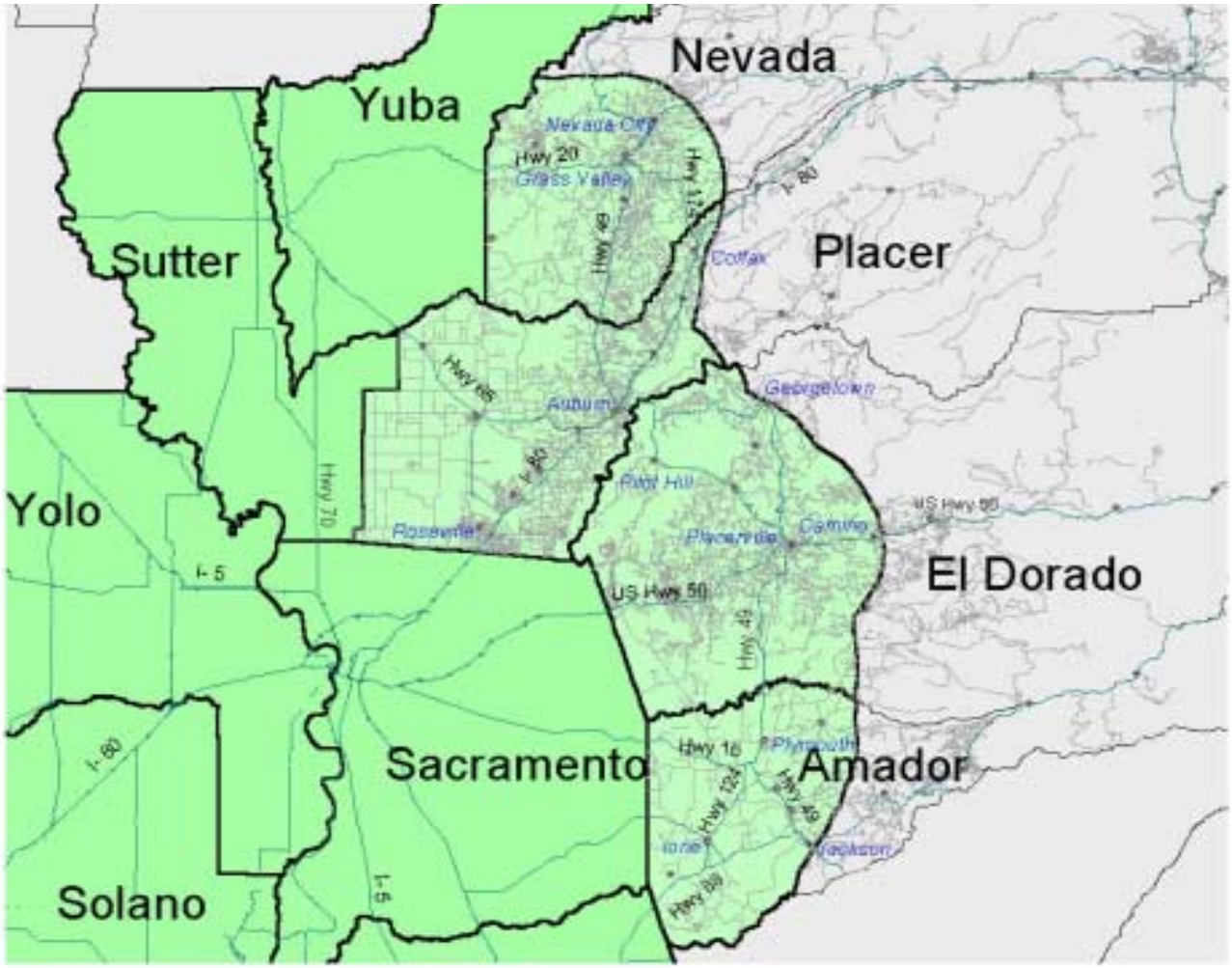
- Representative of service area elevations mostly ≤3,000 ft.

SACRAMENTO PHASE I PROJECT AREA



EASTERN SACRAMENTO PROJECT AREA

(with secondary roads revealing concentration of population)



Western Sierra

- Primary Area
- Potential Area
- County Borders
- Primary Roads
- Secondary Roads

Potential area shown extends 10 miles North of Hwy 20 and East of Hwys 49 and 124

1-12-2000

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SACRAMENTO PHASE I PROJECT AREA

- Leveraging existing equipment may include making use of existing infrastructures where practicable
  - Example: The County of Sacramento has a five-site, twenty-five channel analog trunked radio system with portable coverage outside buildings if held at head level
  - CHP has a need for coverage within many of Sacramento's state buildings. These buildings are, in many cases, dense.

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ECONOMIES OF SCALE

- Benefits Derived Through Collaboration:
  - Significant non-recurring engineering (NRE) being performed on behalf of the statewide PRISM Program and PRISM Initial Project has the potential to significantly benefit the non-state candidate PS subscribers and vice versa; i.e., they would benefit from the economies of scale afforded by being one of many in pursuit of common goals
  - The State will benefit by being one step closer towards achieving its vision of seamless multijurisdictional, multioperational interoperability

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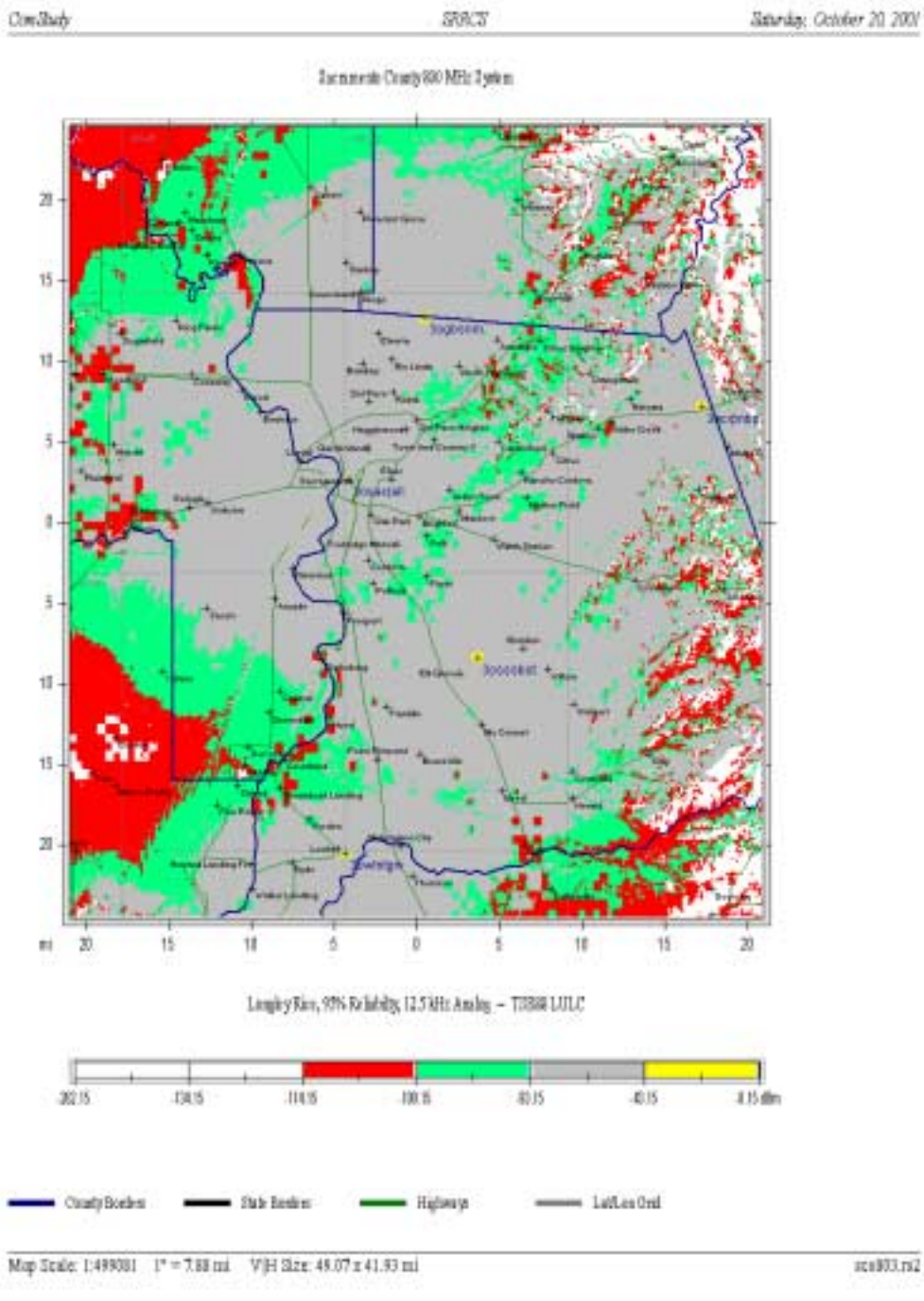
Sacramento County 5-Site System

Gray = mobile coverage (outside buildings)

Note: Coverage represents *predicted* coverage based on model used by CA DGS TD; actual coverage will vary.



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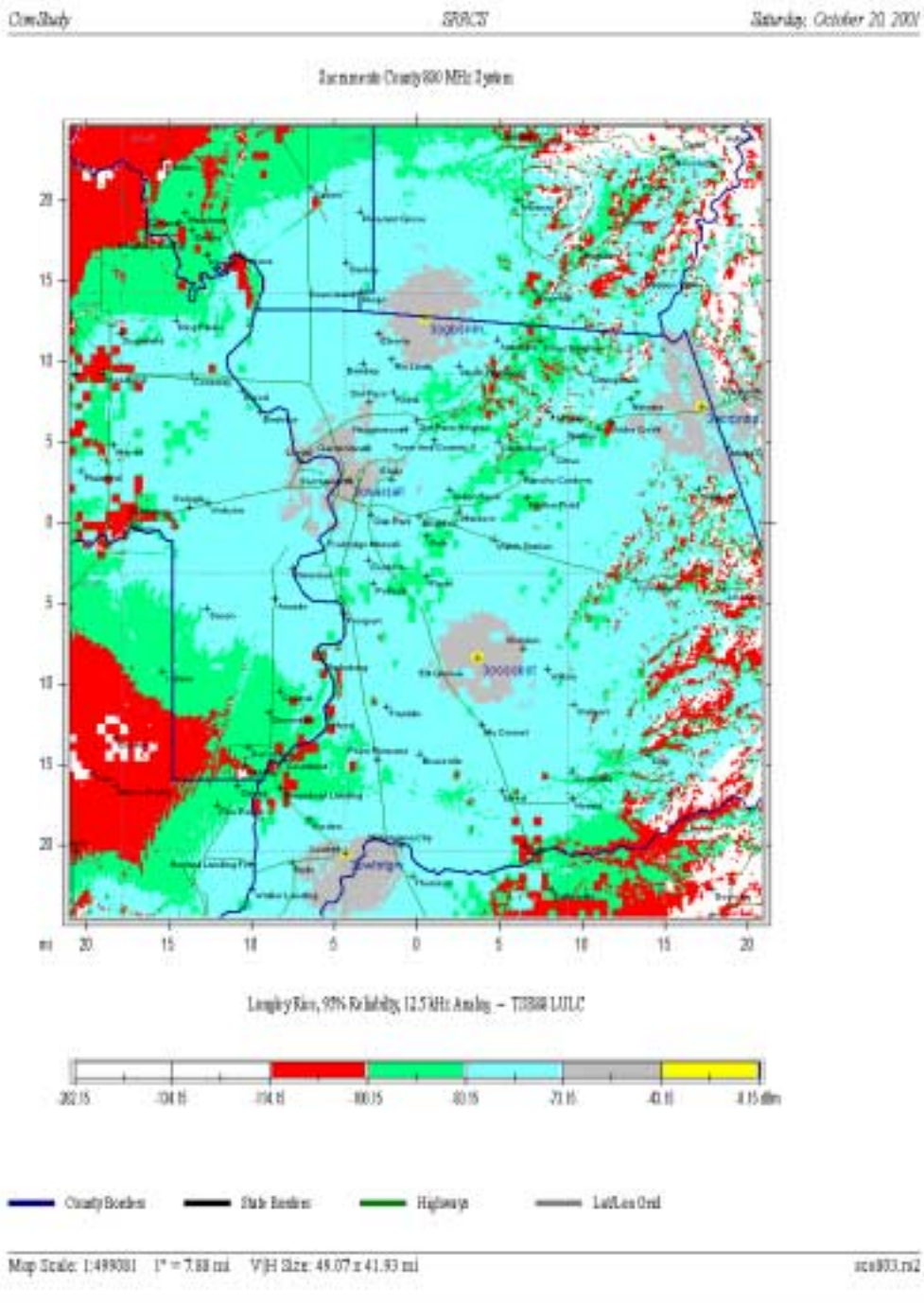
Sacramento County 5-Site System

Gray = portable coverage inside buildings (assuming a 20dB margin required)



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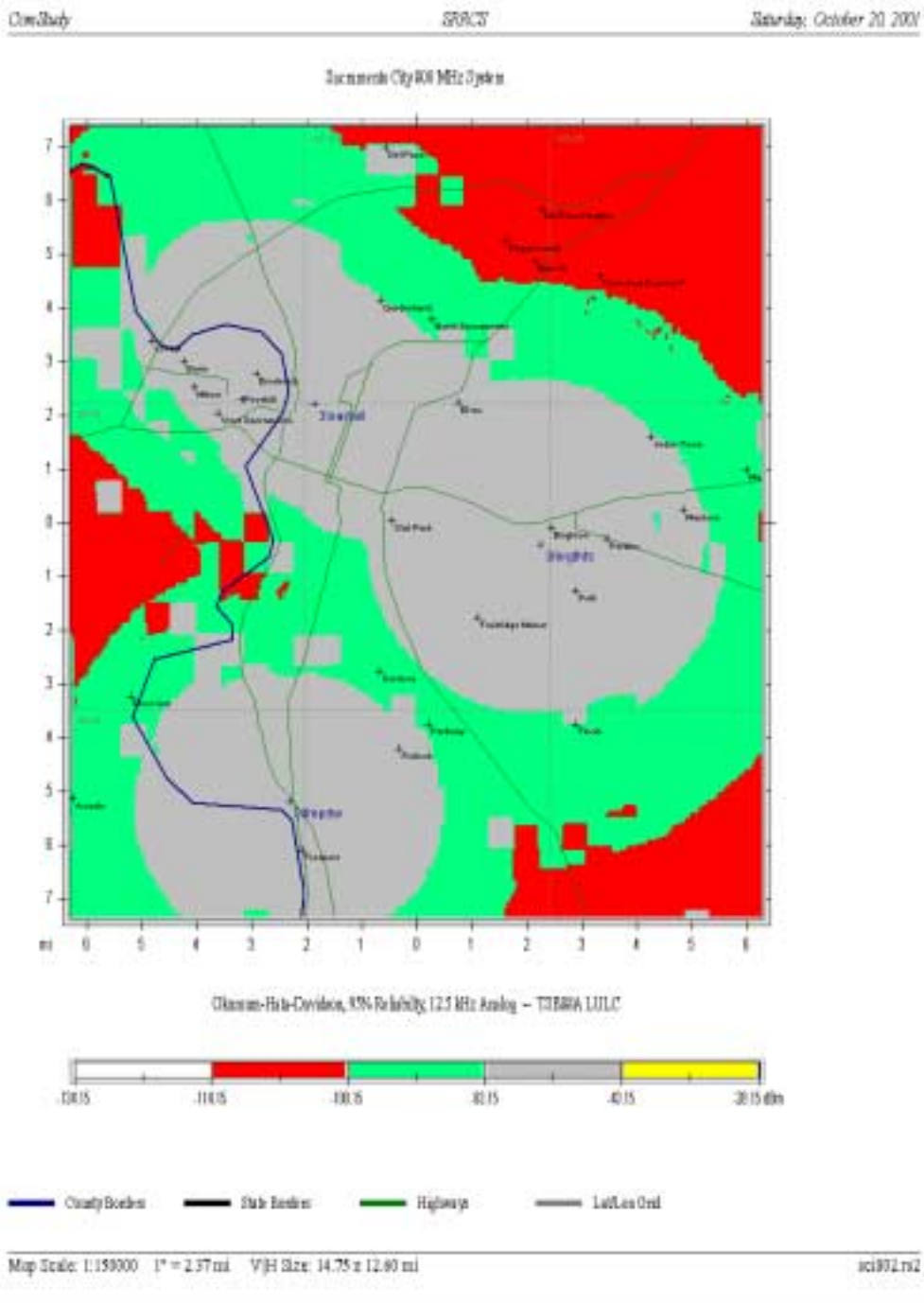
Sacramento City 3-Site System

Gray = mobile coverage (outside buildings)

Note: Coverage represents *predicted* coverage based on model used by CA DGS TD; actual coverage will vary.



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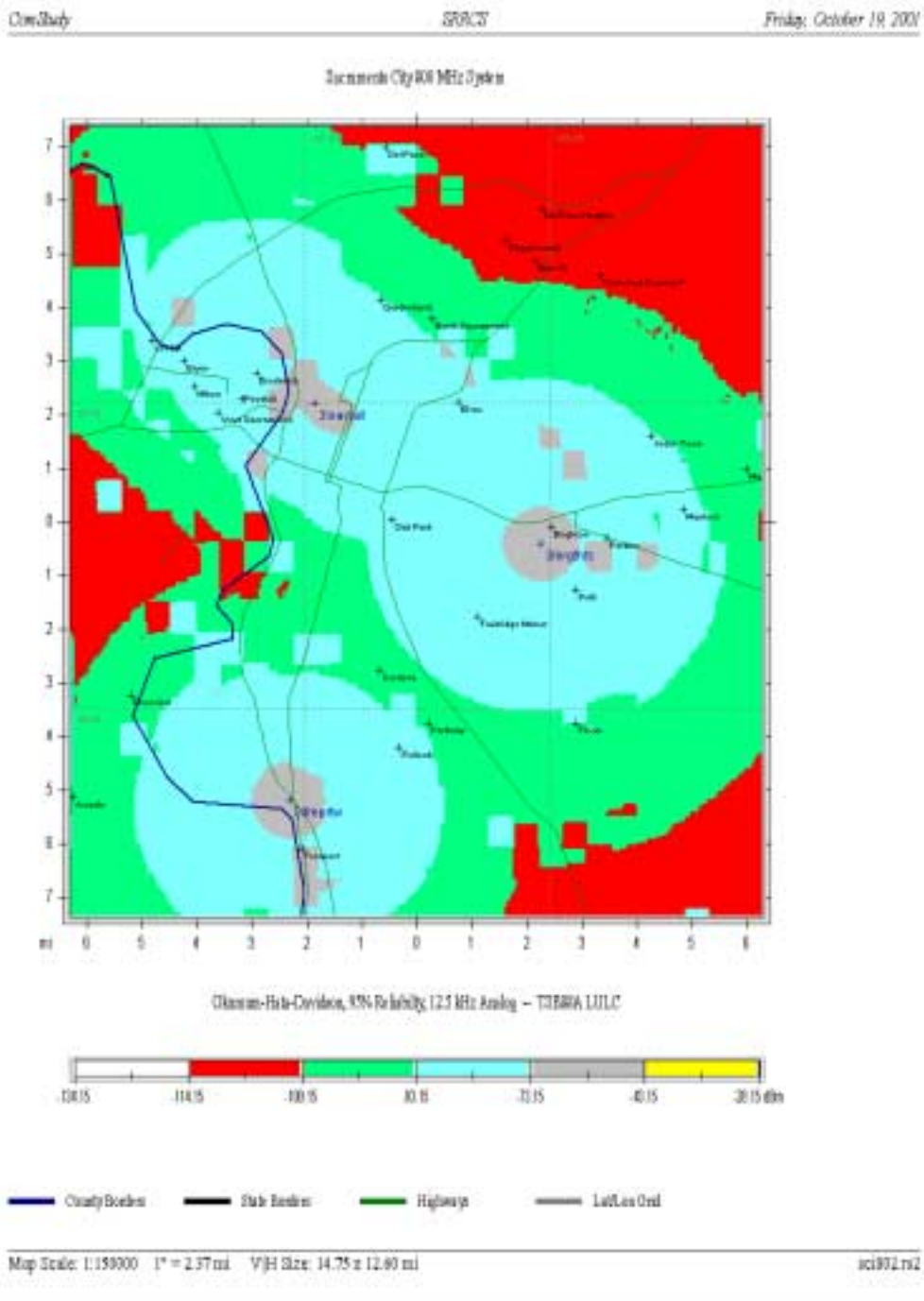
Sacramento City 3-Site System

Gray = portable coverage inside buildings (assuming a 20dB margin required)



Public-Safety Radio Integrated Systems Management

TV Channels 63, 64, 68, and 69

(63 = 764-770 MHz; 64 = 770-776 MHz; 68 = 794-800 MHz; 69 = 800-806 MHz)

- Why 764-806 MHz
  - adjacent to 806-869 MHz spectrum
  - structured allocations
  - imminent channel pair availability in this frequency range
  - only large block of public safety spectrum becoming available in the foreseeable future
- as such, it is the spectrum most conducive to allowing for wide area coverage

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Licensed as Full-Power Digital TV Channels

Protected until at least 2007

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Licensed as Full-Power National Television System Committee (NTSC) Channels

Protected until at least 2007

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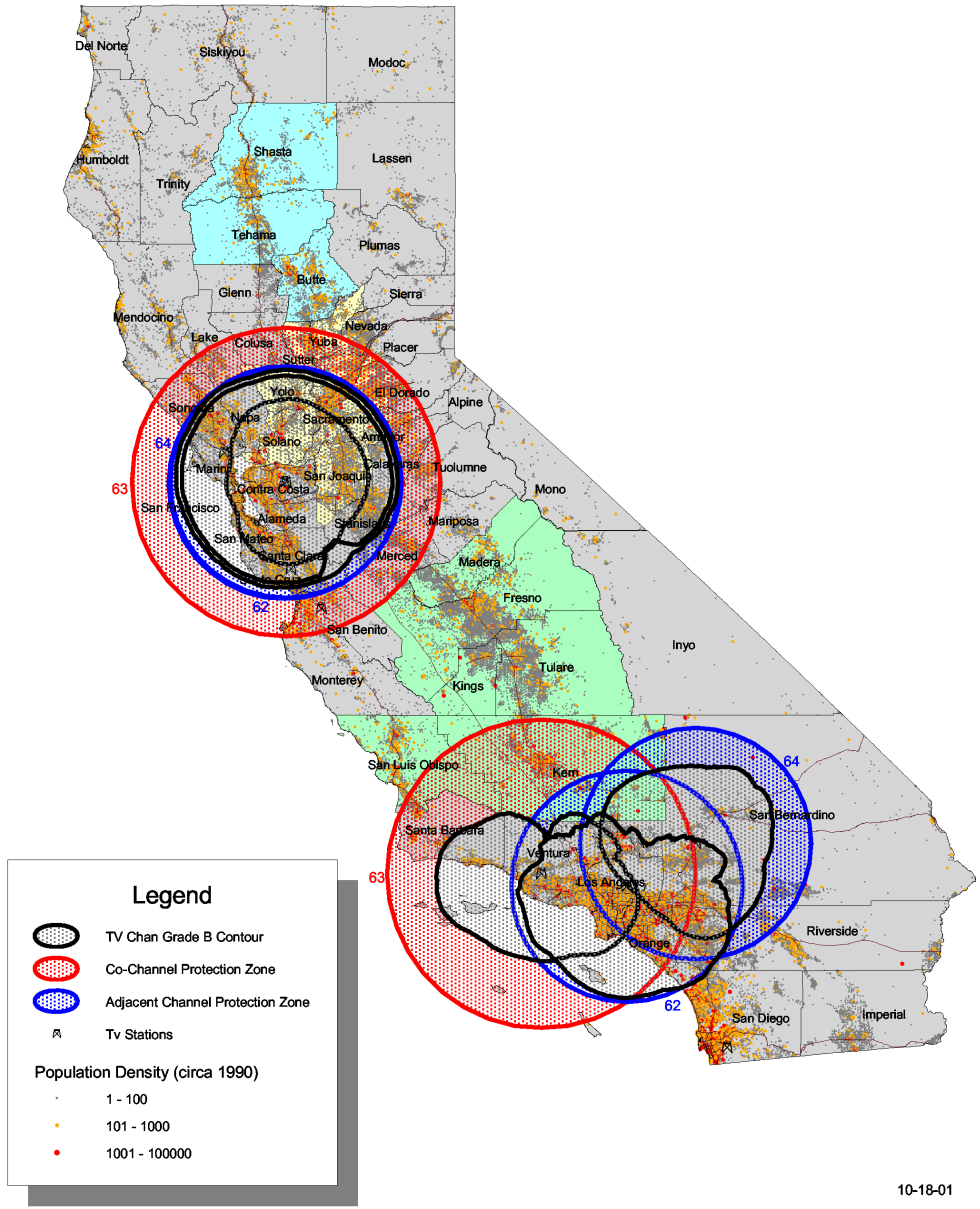
Phase I Implementation Area Alternatives

TV Channel 63 Protection Regions



Reflects Co-Channel (red) and Adjacent Channel (blue) protection regions

Co = 63;

Adjacent = 62, 64

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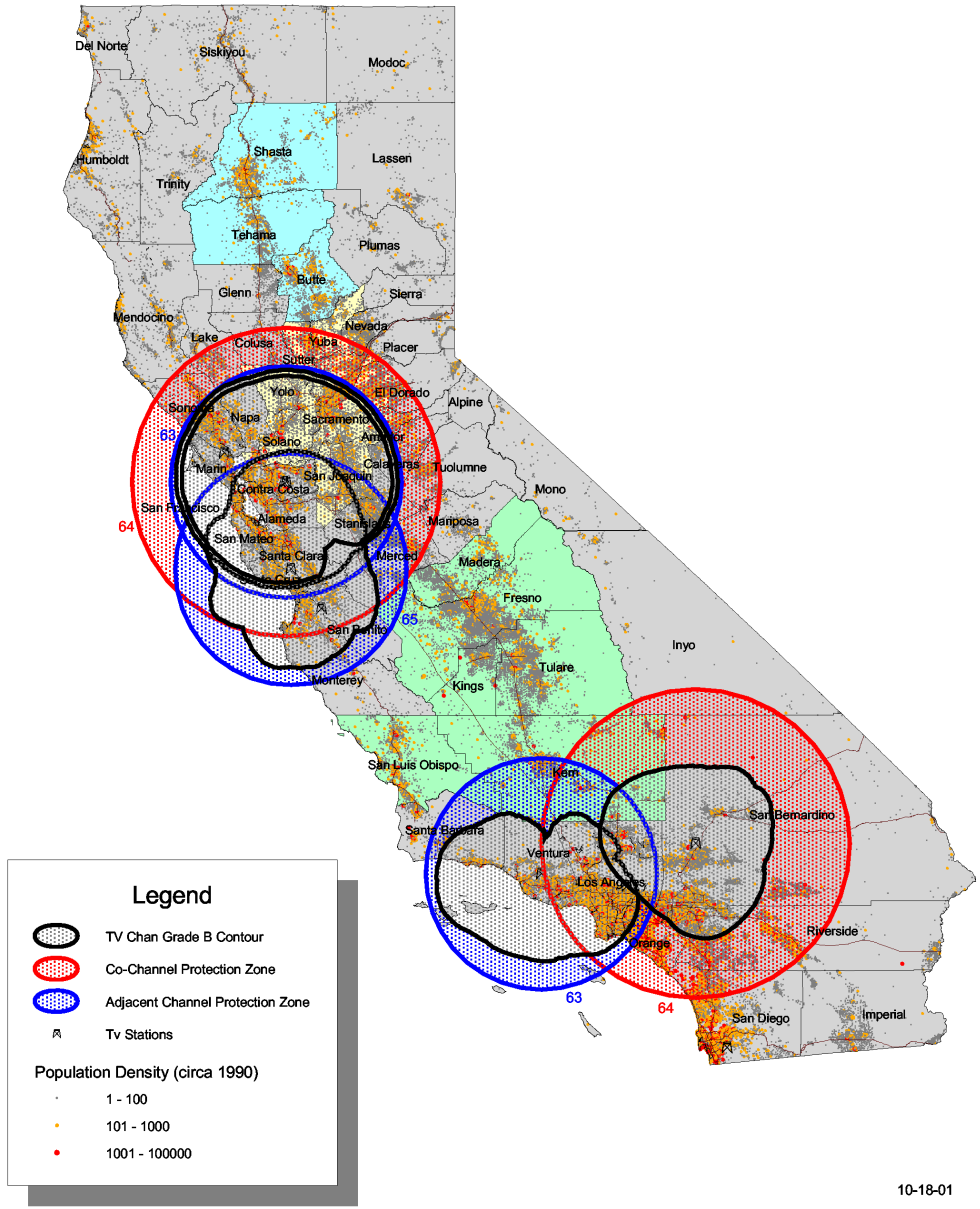
Phase I Implementation Area Alternatives

TV Channel 64 Protection Regions



Reflects Co-Channel (red) and Adjacent Channel (blue) protection regions

Co = 64;

Adjacent = 63, 65

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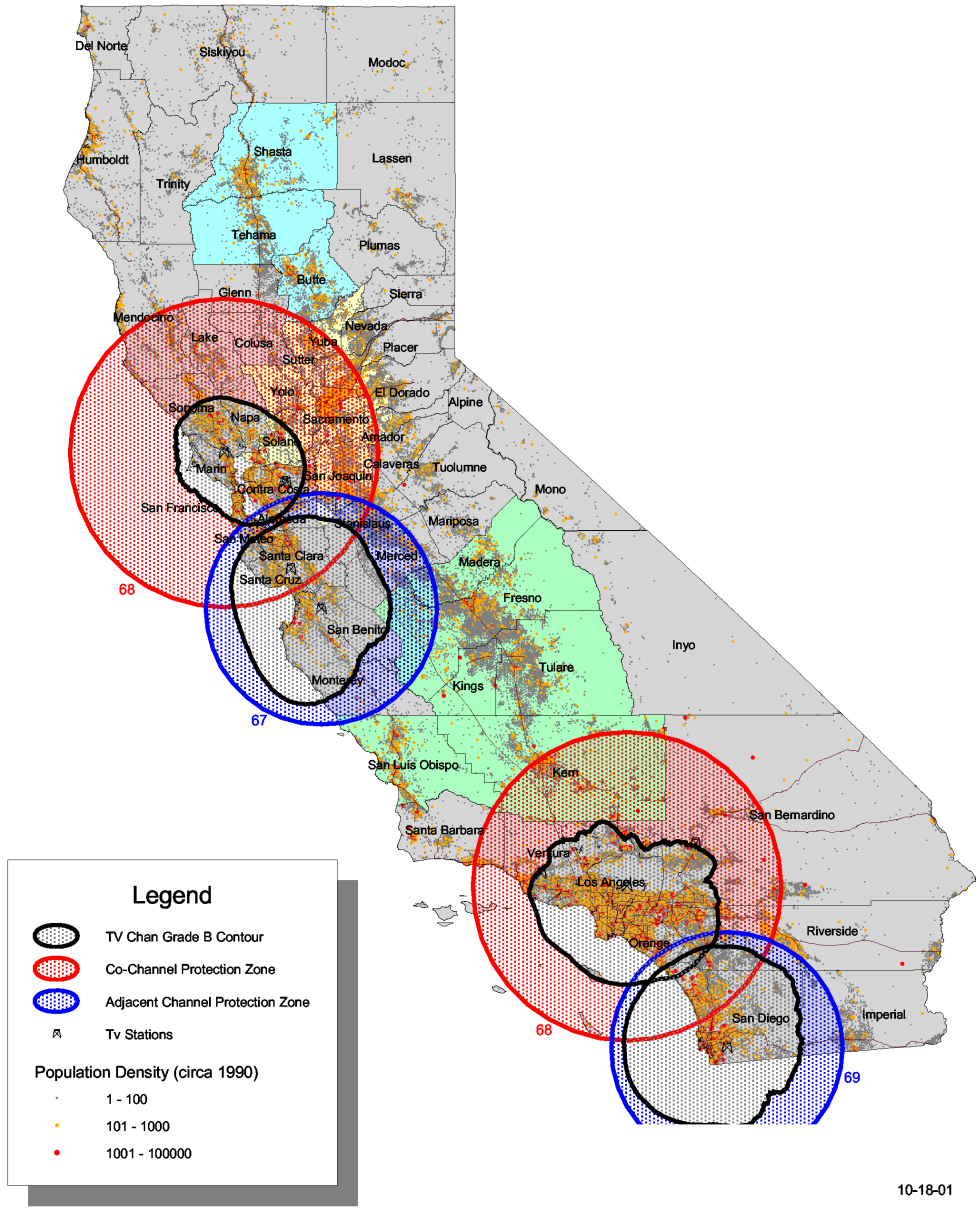
Phase I Implementation Area Alternatives

TV Channel 68 Protection Regions



Reflects Co-Channel (red) and Adjacent Channel (blue) protection regions

Co = 68;

Adjacent = 67, 69

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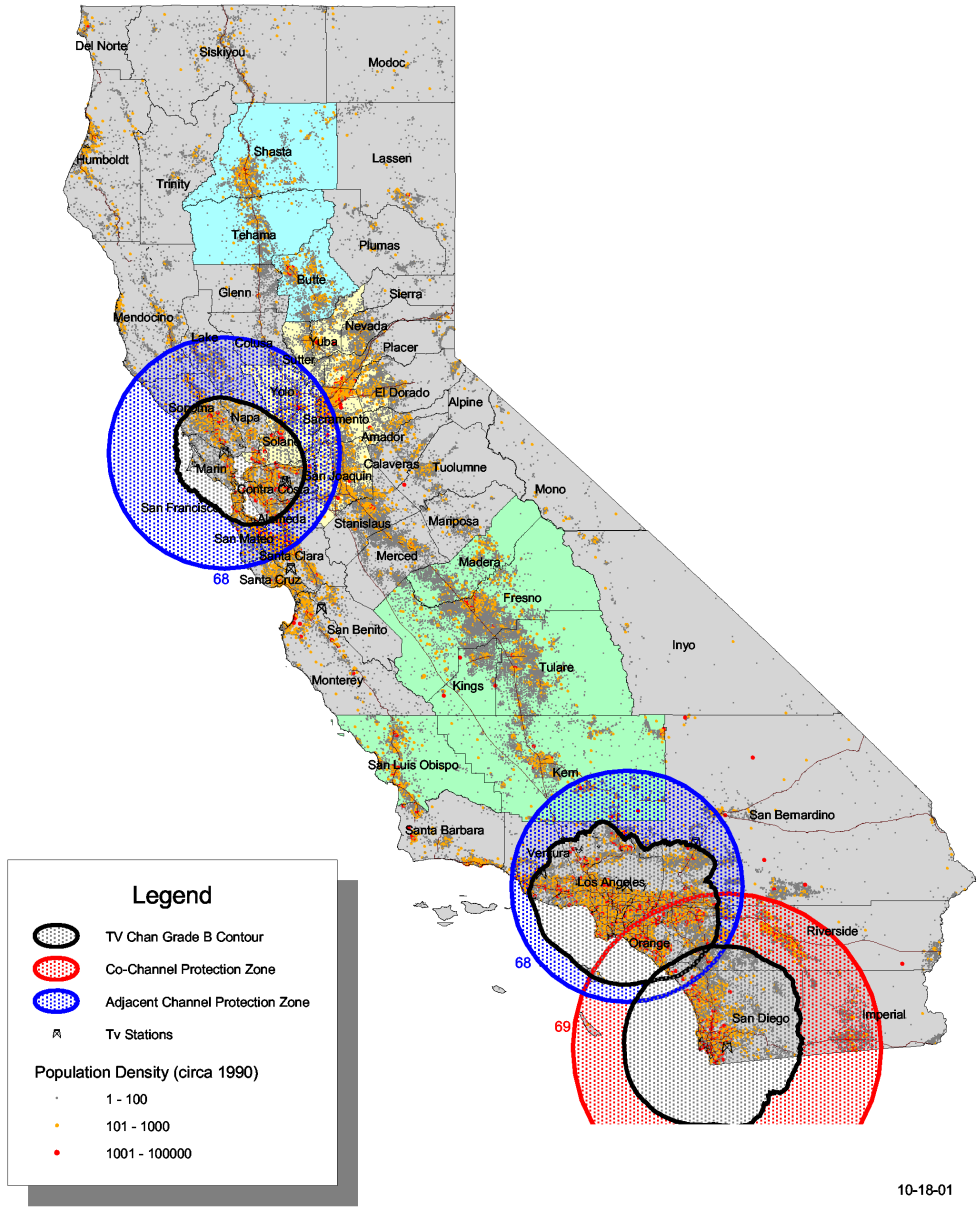
Phase I Implementation Area Alternatives

TV Channel 69 Protection Regions



Reflects Co-Channel (red) and Adjacent Channel (blue) protection regions

Co = 69;

Adjacent = 68

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CENTRAL VALLEY PHASE I PROJECT AREA

- Will comprise some subset within six full counties with an aggregate area of ≈ 25,762 mi^2
- Some of the area designated as National Parks and National Forests
- Currently investigating a service area of about 9,100 mi^2
- Comparable in area to Massachusetts at 9,241 mi^2, New Hampshire at 9,283 mi^2, or New Jersey at 8,215 mi^2

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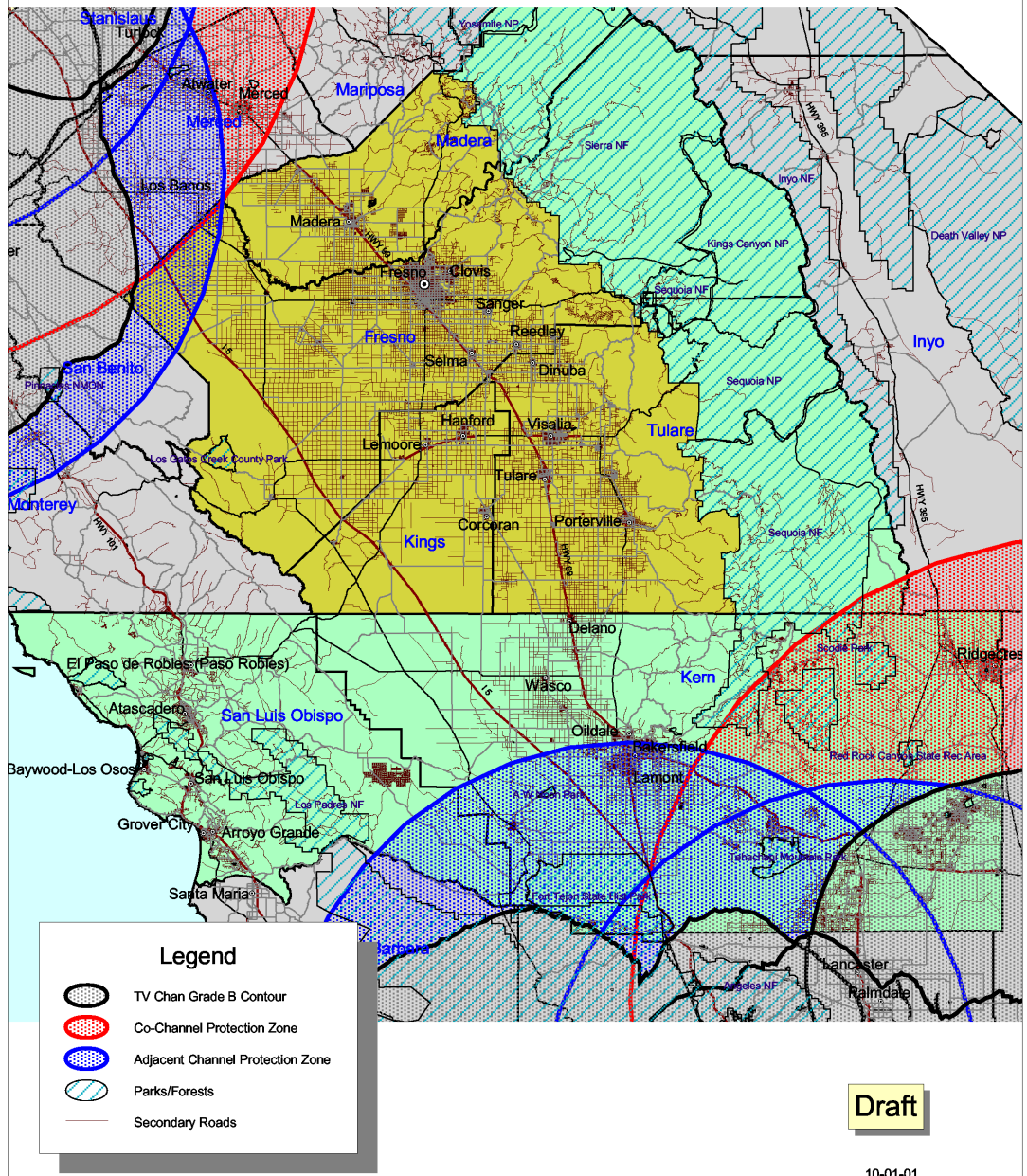
Central Valley Phase I Implementation

TV Channel 64/69 Protection Regions



Gold Area plus a few sites in green area being considered for Phase I.

Note: Public-safety channel pairs in the 64/69 range are the least impacted by commercial TV providers.

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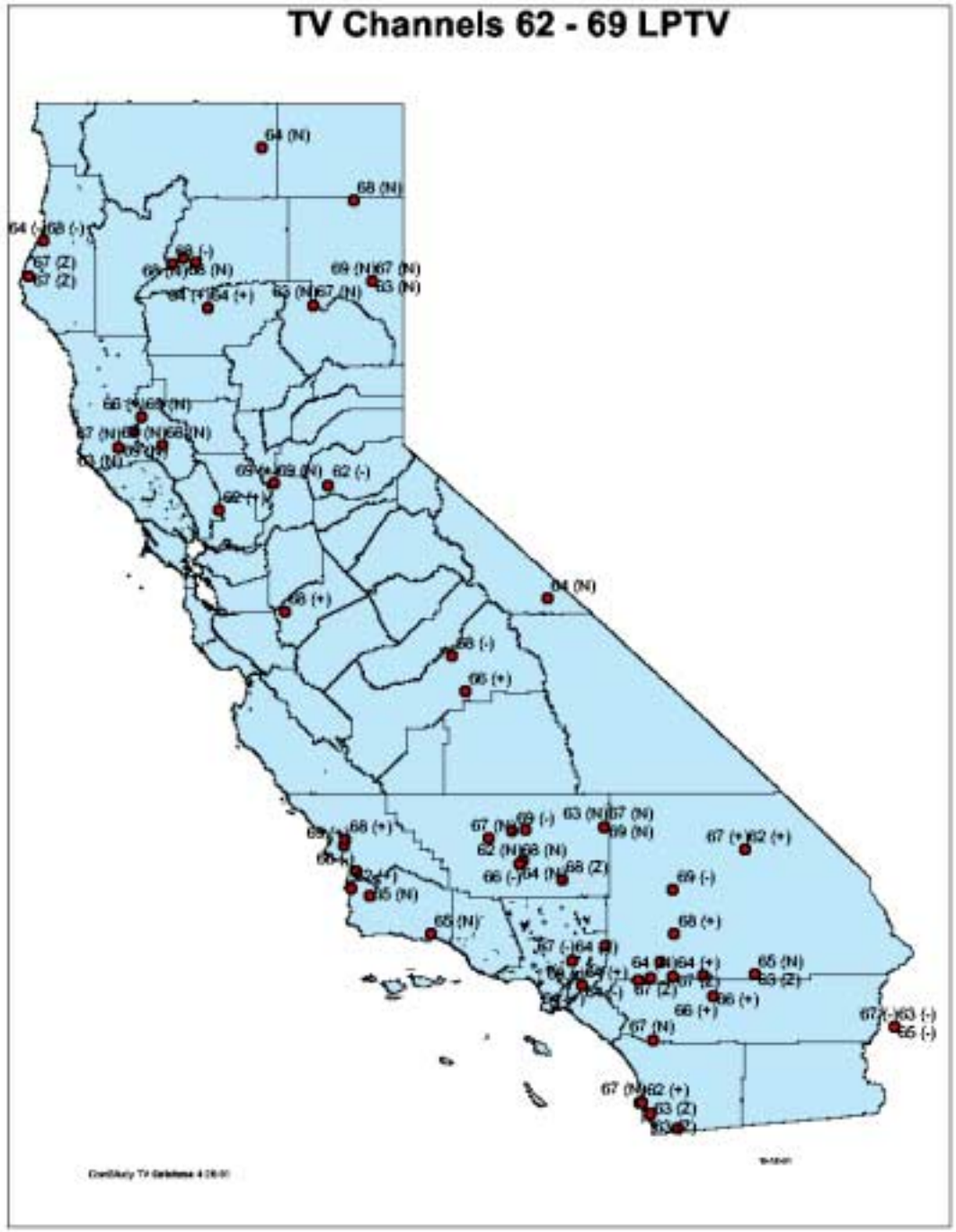


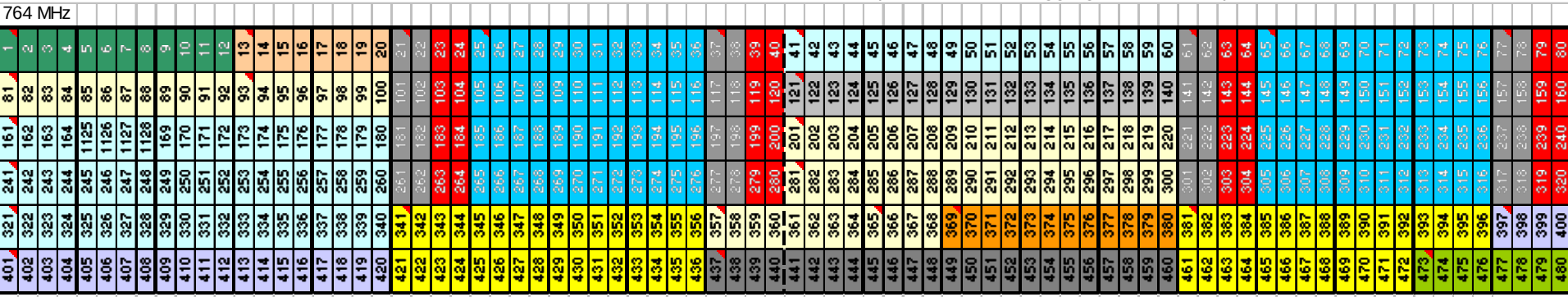
Other Considerations:

LPTV stations are secondary, but should be apprised well in advance of intentions

Region 5 (Southern CA) 700 MHz Regional Plan Draft Channel-Pair Distributions as of September 2001

480 NARROWBAND BASE CHANNELS - SEGMENT 1 (6.25 kHz each, aggregate to 25 kHz)

764 MHz



767 MHz

120 WIDEBAND BASE CHANNELS - SEGMENT 1 (50 kHz each, aggregate to 150 kHz)

767 MHz

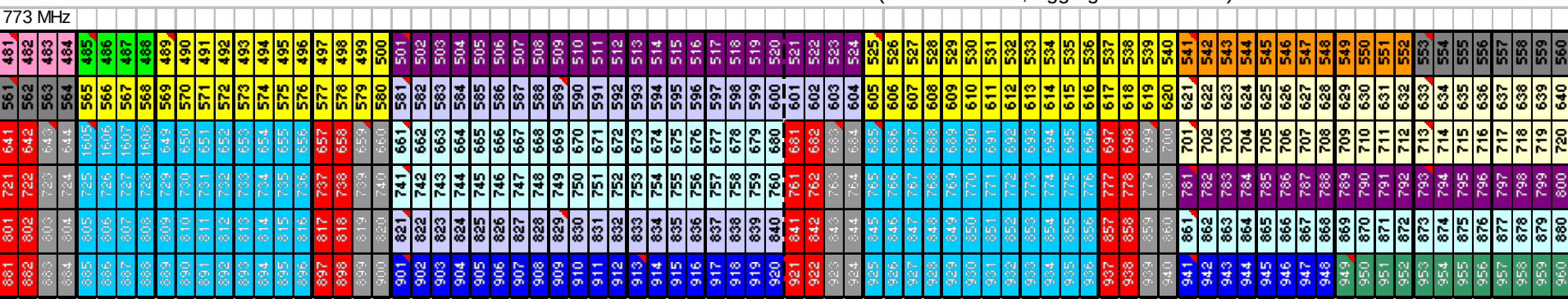
1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18
19	20	21	22	23	24	25	26	27
28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54
55	56	57	58	59	60	61	62	63
64	65	66	67	68	69	70	71	72
73	74	75	76	77	78	79	80	81
82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99
100	101	102	103	104	105	106	107	108
109	110	111	112	113	114	115	116	117
118	119	120						

773 MHz

GENERAL USE
INTEROPERABILITY
RESERVE
STATE LICENSE
LOW POWER
STATE GENERAL USE FREQUENCIES

480 NARROWBAND BASE CHANNELS - SEGMENT 2 (6.25 kHz each, aggregate to 25 kHz)

773 MHz



776 MHz

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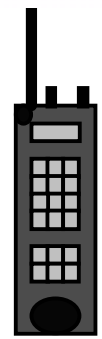
INTERIM CONFIGURATIONS
(CHP Example)

Conventional & Trunked Radio Communications System Comprised Of:

- Decreasing # of Conventional Analog Mobile/Portable Extender Combinations;
- Increasing # of Digital Trunked Mobile/Portable Extender Combinations
- Decrease in Leased MDC Services;
- Increase in Diversified Access to Data Sources via MDC's

- Decreasing # of Conventional Analog Portable/Extender Units
- Increasing # of Trunked Digital Portable/Vehicle Extender Units



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FINAL CONFIGURATION
(CHP Example)

WHERE WE ARE GOING

Trunked Voice & Diversified Data Communications System Featuring:

Enhanced Interoperability With Allied Agencies

Secure Communications

Digital Portable/Extender Units

Digital Mobile/Portable Extender Combinations;

Various Access Paths to Data Sources via MDC's

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Questions

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Bill De Camp (916) 657-9205 (DGS Telecom)